NATURE

No. 4115 SATURDAY, SEPTEMBER 11, 1948 Vol. 162

CONTENTS

	Page
Balance Between the Pursuit and Application of Science	385
Plant Communities. By Dr. W. B. Turrill	387
Local Genii of British Folk-Belief. By Dr. E. J. Dingwall	388
The Graduate in Industry. By R. Brightman	388
Sea Waves and Surf. By N. F. Barber	389
Free Radicals in Chemistry. By G. Porter	390
Stellar Astronomy. By Dr. R. d'E. Atkinson	390
British Association Meeting:	
The Passing World. By Sir Henry Tizard, K.C.B., F.R.S.	392
Summaries of Addresses of Presidents of Sections	399
News and Views	407
Letters to the Editors:	
Creep of Metals and Recrystallization.—Prof. E. N. da C. Andrade, F.R.S.	410
Creep of Metals Subjected to Compression Stress.—A. H. Sully, G. N. Cale and G. Willoughby	411
Isotopic Assignment of the α-Activity of Samarium.—Prof. N. Feather, F.R.S.	412
Spectrum of Helium-3.—L. C. Bradley and Dr. H. Kuhn	412
Vibrating Electrodes in Polarography.—E. D. Harris and A. J. Lindsey	413
Evidence of Geological Age against Decay of Tin-115 to Indium-115 by Electron Capture.—Dr. L. H. Ahrens	413
Human Colour Vision and Granit's Theory.—Dr. R. W. Pickford	414
A Simple Technique for the Differential Staining of Lignified Cell Walls.—Dr. Iwo R. W. Lominski and S. A. Hutchison	415
Influence of Time and Temperature of Storage on Dye-Reduction Tests in Milk.—R. K. Morton and J. M. Vincent	415
Pregnancy Test using the Male Toad.—Dr. Magnus Haines	416
Shortage of Scientific Text-books.—John Grant; Roy Innes	416
International Exchange of Scientific Information.—Prof. N. F. Mott, F.R.S.	417
The Core of the Insulin Molecule. By Dr. J. A. V. Butler, D. M. P. Phillips and Miss J. M. L. Stephen	418
Birefringence and Orientation-Rate of the Leptones of Protoplasm. By Dr. Hans H. Pfeiffer	419
Carnegie Institution of Washington	421
International Committee for Bird Preservation	422
Bioluminescence. By Dr. V. B. Wigglesworth, F.R.S.	423
Symposium on Searchlights. By Dr. W. M. Hampton	424
Afforestation for Bengal. Prof. E. P. Stebbing	424
The B.B.C. Quarterly	425

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London

Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone: Temple Bar 1942

The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad

All rights reserved. Registered as a Newspaper at the General Post Office

BALANCE BETWEEN THE PURSUIT AND APPLICATION OF SCIENCE

IN title, and, to some extent, in content, Sir Henry Tizard's presidential address to the British Association (see p. 392) recalls that of General Smuts to the centenary meeting in London, though in form the outlook of the present chief scientific adviser of the Government resembles rather that of the engineer, as it was put by Sir Alfred Ewing. All three addresses glance at that Victorian era, the ideas and beliefs of which must have been made more familiar to many of Sir Henry's audience by the series of talks broadcast in the B.B.C. 'third programme' this spring. Already, however, the scientific world picture which General Smuts outlined has changed considerably, as indeed he indicated it would do; and although Sir Henry Tizard did not pursue the philosophical theme of the centenary address to the British Association, it is clear that one or two of its points were in his own mind.

Science now, as he pointed out, stands higher in the public esteem than it has ever done in Britain. The public controversy between science and religion has died down, and the recent report of the Lambeth Conference provides evidence of a changed attitude and outlook on the part of the churches assembled there that would have seemed startling indeed to the Victorians, even to those with scientific interests who gathered in Brighton for the meeting of the British Association in 1872. Indeed, the frankness, clarity and logic of that report may well astonish many men of science who have not yet realized how truly science and religion stand on the same side in the defence of freedom and the moral, spiritual and cultural values of civilization.

At these values Sir Henry, however, gave no more than a passing glance. Instead, we have been given a world picture in which the central and dominating figure is man and his activities. The world, he suggests, is passing from one state of unstable equilibrium to another, and will be unstable for many years to come. We can at least strive to balance it so that the chance of a major catastrophe is made as small as possible, and Sir Henry holds that science has much to contribute towards this aim. We should ask ourselves whether we are not claiming too much for science in some directions, and doing too little in others; and, in words that recall those of General Smuts and also those of Sir Alfred Ewing, he suggests that we should consider in fact whether the great forces of science, on the proper exercise of which all social progress depends, are in balance.

The balance to which Sir Henry addresses himself more particularly is not that between ethical and material values, between science, art and religion, but between the pursuit and the application of science. To read his presidential address is to realize the extent to which his master mind is influencing the work of the Advisory Council on Scientific Policy as revealed in its first annual report. Some of his remarks may fail to reach all the industrialists or professors or directors of research for whom they are plainly intended; but Sir Henry's position justifies

the confidence that he will not fail to make those views known in any quarter that may be desired.

This part of the address is essentially a sermon on economic recovery. Sir Henry suggests that one of the lessons of the last two generations is that the decline in the prosperity of some branches of industry is due to their tendency to go on doing what manufacturers know they can do successfully rather than to launch out in new directions. Sir James Morton, for example, used to contend strongly that this was the real reason for the depression in the cotton industry in the nineteen-twenties; Sir Henry himself suggests that this rather than the neglect of science was the real reason for the development of synthetic dyes and fine chemicals in Germany rather than in Great Britain.

But after a tribute to the quality of the reserve of scientific ability in Britain as revealed in both the world wars, and a warning as to the importance of maintaining the quality of academic research, Sir Henry puts in a timely protest against excessive drift of scientific man-power to the universities. He wonders whether we are not already over-populating the research departments of universities. Industrialists, who are looking patiently to the universities to provide the recruits to their research and production departments which they are at present unable to find may share that wonder. They may equally believe that university research departments are not the only over-populated departments, and the subsequent reports of the Advisory Council on Scientific Policy will certainly be scanned for evidence that the chairman is making his own views on the distribution of scientific man-power effectively prevail.

There need be no fear that whatever action the Advisory Council may inspire will impair the high standard of teaching in the universities or the schools of Britain, or impede the expansion of education in the higher branches of technology. We have become a scientific nation, but there is still too slight an understanding of the nature and the limitations of research; and a main theme of Sir Henry's address is that which recurred in the annual reports of the Department of Scientific and Industrial Research before the War. Sir Henry contends that industrial prosperity will depend more and more on the continuous application of science to industrial practice. Without disparaging new knowledge or research, he points out that the first requirement at the present time is the application of existing knowledge.

The prime object of industrial research is to do something that has never been done before, or to do things better than they have ever been done before. Furthermore, all social progress, such as the spread of education, promotion of health, and opportunities for leisure and healthy recreation, must depend on the power of science and technology to increase the productivity of industry. The productivity of labour in Britain is far lower than it could be if the results of past research were more resolutely and continuously applied. Sir Henry instances building, the coal industry and textiles, and suggests that the real reason for the higher productivity of such countries as Sweden and Switzerland is not in superiority of natural resources or in the quality or quantity of scientific and industrial research, but in their higher average standard of technology and in the greater proportion of men of high scientific education in executive control of industry.

It is not the general expansion of research in Great Britain that is of the first importance for the restoration of its industrial health, and certainly not the expansion of Government research remote from the everyday problems of industry. In Sir Henry's view the immediate task should be to apply what is already known. That view will be welcomed by many for its implications in regard to the distribution of man-power; but before considering two of these implications in particular, it is interesting to note that without using the stock term 'operational research', Sir Henry commends as one practical means of assisting the application of existing knowledge the technique used in progressive industry in technical service long before the War and developed with such remarkable success by the fighting services in the attack on problems of war.

The concluding observation in this connexion brings out the really vital factor in the utilization of science to-day. In the technique to which Sir Henry refers, far more attention is given to the study of man in relation to the machine he has to operate than in any branch of industry. Those industries which have gone furthest in that direction are precisely those in which human troubles, if not entirely absent, are most inconspicuous. In them, therefore, under such conditions, is there the best prospect of achieving that special object which all industrial research should have, namely, of reducing the labour required to supply the material needs and wants of men.

The central problem in the utilization of scientific knowledge in our economic recovery is thus that of man: of the wise use of man-power, of distribution or redistribution, and of securing the willing and intelligent co-operation essential for the full use of the new powers which applied science has given us. The importance of the work of the committee on human factors concerned in industrial productivity, of which Sir George Schuster is chairman, could scarcely have been better emphasized. Although Sir Henry's direct responsibilities in that field have now ceased, it seems certain that the work initiated by the Committee on Research and Productivity will continue to be watched by him with interest and firm support.

On the material plane, subject to the qualifications already indicated, Sir Henry takes a hopeful view of the future. He is reassuring on the question of food supply, but points out that it is on the development of the biological sciences that the peace and prosperity of the world depend. He considers that, so far as Great Britain is concerned, we must plan our economy on the assumption that food will be both scarce and dear for many years to come; and the answer to the question how long depends less on the ability than on the will of man.

"Science", said General Smuts at the centenary meeting of the British Association, "has come to

represent the growing point of the human advance. It stands for the new forces which are re-shaping this world of ours. It faces the future with a bold and confident spirit. It has an invincible faith in truth at all costs; and in that faith it is embarked on the endless adventure which carries the future of the human race."

In seventeen years we have lost something of that confidence in science, and in spite of the respect to which Sir Henry Tizard rightly referred, there have been new doubts as to the sufficiency of science. Science alone, it is widely held, is not enough; and in the world of science there are many who believe with the Lambeth Conference that technical discovery must be brought into line with ethical direction. Sir Henry Tizard recognizes that we live in difficult times, but it is from Whitehead rather than Smuts that he draws his inspiration when he urges that it is a time for adventure, for taking calculated risks.

Sir Henry's contacts with the universities and with industry have convinced him that the spirit of adventure in science is as lively as ever it was. He looks forward to the future in the belief that by finding the right way to combine originality in science with enterprise and speed in its application, the nation can climb from the depths of bankruptcy to new and unsurpassed heights of prosperity and influence. Some successor in the presidential chair may or may not have occasion to refer to the great influence of the work of a few young men, who are now unknown to the public. Sir Henry's audience will look forward to that future with the greater confidence, because one whose foresight did so much to prepare our scientific resources for war is in the position to influence as potently their ordering for the tasks of economic recovery and of peace.

PLANT COMMUNITIES

The Study of Plant Communities

An Introduction to Plant Ecology. By Prof. Henry J. Oosting. Pp. 389. (San Francisco: W. H. Freeman and Co., 1948.) 4.50 dollars.

SINCE plant ecology first started, as a distinct division of study within the major science of botany, with the publication of Warming's "Plantesamfund" in 1895 (first German edition in 1896 and an English edition, "Oecology of Plants", Oxford, 1909), it has owed much of its rapid growth to American workers. In particular, the concept of succession was clarified and systematized, if not conceived, in the United States, and its development has been stimulated and largely directed by the researches, terminology and theories of American ecologists. It is therefore to be expected that textbooks of ecology intended primarily for American students should record progress periodically. Such works naturally have both peculiar value and particular limitations for students in other countries. They direct attention to points of view and literature which might otherwise be overlooked and to examples which might remain unknown. On the other hand, it is not always easy to evaluate the conclusions reached because of unfamiliarity with both the flora involved and the field conditions.

The book under notice covers fairly adequately the subject of plant communities or synecology as an introduction to a part of plant ecology. After a preliminary discussion on the subject-matter of ecology there are five parts, with a total of eleven chapters, dealing with the plant community, factors controlling the community (the environment), community dynamics and practical considerations. A useful distinction is made early on, and emphasized several times later, between a concrete or specific example of a community and the abstract community as a synthetic idea derived from a study of several or many concrete examples or stands. Terminology is introduced gradually in the text and nowhere overwhelms the reader. Divergent points of view are judiciously treated. For example, the description and classification of communities, as developed especially by European writers, is contrasted with the view of vegetation as changing by development from origin to climax. Yet "each method has its place and usefulness. In fact each has profited from the other, but since the dynamic point of view has the broadest usefulness in both pure and applied ecology, it will be emphasized here." Importance is rightly given to the need for quantitative data in vegetational analysis. Refinements of the quadrat method, density, frequency, cover and space are considered. Qualitative characters, including sociability, dispersion, vitality, stratification, and periodicity, and "synthetic characteristics", such as presence, constancy, and fidelity, are discussed.

Considerable space is devoted to describing the factors controlling the community and the methods of measuring them and their influence on vegetation. Climatic, physiographic (mainly soil), and biological factors are dealt with in four chapters. The treatment accorded is on the whole adequate and up to date so far as American research is concerned, but would have been improved by the inclusion of European research, especially on 'biological' (or better, 'biotic') factors. The account of plant competition, for example, could have been much improved by reference to published researches on British vegetation.

A concise account of plant succession is followed by a very useful chapter on the distribution of climax communities in North America. This summary of the principal vegetational features of the continent is likely to be welcomed by many students of plant geography. The chapter on shifts of climaxes with time suffers from having only very brief references to work done outside North America, and from overcondensation, especially of the subject of pollen analysis.

The final chapter, on applied ecology, is to be commended as linking up scientific investigations with the satisfaction of human needs in the practices of forestry, agriculture, conservation, water supply, and what is termed 'landscaping'. The extent of this chapter could have been enlarged with advantage.

The book is illustrated with 190 figures. These are mostly well-chosen and fairly well-reproduced photographs, but include some outline drawings. There are also a number of tabulations. Besides "General References" at the ends of chapters there is a list of 276 "References Listed". The vast majority of the references are to American publications. It is, for example, surprising to find only two or three references to papers in the *Journal of Ecology*, which was not only the pioneer of ecological periodical literature but has always been and is still in the first rank. There is an adequate index.

A general criticism, which has already been indicated, is the relative neglect of non-American investigations. One would naturally expect emphasis to be given to American work and examples to be chosen largely from North American vegetation; but more consideration of various methods of study, both of vegetation itself and of the factors of the environment, which have been developed in Europe and elsewhere would have added greatly to the value of the first half of the book. It is also unfortunate that, in common with many other text-books of ecology, the dependence of good ecological work on the correct determination of the organisms composing the communities studied is not stressed.

W. B. TURRILL

LOCAL GENII OF BRITISH FOLK-BELIEF

The Minor Traditions of British Mythology

By Lewis Spence. Pp. 176. (London: Rider and Co., 1948.) 16*s*. net.

THIS volume is an attempt to present in concise and summarized form some of the lesser facts and circumstances of British mythology which, although dealt with in some detail by writers in the more specialized journals devoted to folk-lore, have not yet received adequate attention in more popular books. It has been Mr. Spence's object to collect together many of the more local British traditions as they are expressed in legend and folk-tale, and show how the rivers, mountains, lakes and wells are peopled by a motley collection of goblins and demons, giants and monsters, vegetation spirits and supernatural birds. To the stories concerning these monsters the author has added the legendary material which has collected in such quantity around the standing stones of Britain and the dolmens and menhirs which can be treated with them.

It follows from the plan designed by the author that a good deal of the material with which he deals is concerned with those local genii and solitary spirits who rarely seem to have attained more than a local distinction, but who, in many cases, can be linked up with more prominent mythological figures.

Having discussed the spirits which are connected with British rivers, lakes and wells, Mr. Spence proceeds to give an interesting account of mermaids and seal-folk, and then goes on to discuss the giants and ogres of England. He is of the opinion that many of these gigantic divinities were the original deities of this island; and from the passages he quotes it would seem that at one time Britain must have been the home of many giants, some of whom were guilty of exceedingly unpleasant habits. Passing in review the giants of Scotland, Ireland and Wales, Mr. Spence then continues his narrative by an account of British goblins and demons, a chapter which could, I think, have been considerably enlarged with great advantage to the reader. The author points out that what he calls the demonology of Britain is the equal of any to be found in Europe, and although it does not present the number of fantastic varieties to be found in Germany, the type is broader, owing perhaps to the great admixture of stocks which makes up the British population. How far this is true it would be difficult to determine without a much more detailed examination of the legendary figures and their possible sources than has been attempted here. What is clear is that British goblins have appeared in numberless forms, many of which were described by Scot in his famous sixteenth-century book on witchcraft. Here will be found a catalogue of sprites listed under such names as bull-beggers, sylens, pans, kit with the cansticke, calcars, the hell-waine, the puckle "and such other bugs". Mr. Spence rightly points out that few of the types listed by Scot are actually of British provenance, while others are of the fairy class to which, in the present volume, the author has not turned his attention.

In the discussion of these curious demonic figures some of them are compared with so-called poltergeists, inasmuch as a few were noted for their tricks and troublesome antics. Thus the Hedley kow seems to have been of this type, for it would disguise itself as a truss of straw, and when someone tried to pick it up it would become so heavy that it would have to be laid down to let the bearer have a few minutes rest. Thereupon it would suddenly come to life and shuffle away with a peal of laughter.

It would be of interest to discover whether legends of this sort can be in any way linked up with the many accounts of poltergeist activity to be found in Great Britain. In the present volume, however, Mr. Spence has confined himself to a bald statement of the facts, and the reader is often left with a desire to know more just when his attention is directed to a fresh case. Indeed, the author might have been wiser had he not attempted to deal with so much material in so small a space. In its present form the book is little more than a very convenient and useful summary of the subject; but it would have been much improved if the dates of publication had been added to the material listed under the references, and the index much enlarged so as to include more of the proper names, and not only a certain number of them based on a method of selection the principle of which does not seem to be at all clear.

E. J. DINGWALL

THE GRADUATE IN INDUSTRY

The Graduate in Industry

By Dr. Percy Dunsheath. Pp. x + 276. (London: Hutchinson's Scientific and Technical Publications, n.d.) 10*s*. 6*d*. net.

THIS book is a thoroughly competent piece of workmanship which to some extent breaks new ground in that, unlike most 'careers' books, it indicates the trend of numerous occupations for university-trained men and women in industry and attempts to demonstrate the opportunities for service to the community which lie therein. In this his first objective, Dr. Dunsheath sets out deliberately to overcome some of the prejudices against entering industry which, according to Sir Lawrence Bragg and others, are sometimes manifest among students. While thus endeavouring to satisfy the ideals which often influence such students, Dr. Dunsheath remains essentially factual and has assembled a considerable amount of information not otherwise accessible in one volume, which should make his book of real value to the university appointments boards and to the higher appointments officers of the Ministry of Labour and National Service.

In his preface, however, Dr. Dunsheath indicates a second objective. He attempts to show both the need for a change of approach in university teaching for students destined for a life in industry, and that the new conditions of the present day may be adequately matched to the tradition of the university as a place where young people find a philosophy of life which remains with them to guide and strengthen them throughout the conflicts of life which lie ahead. Here Dr. Dunsheath has much to say that is stimulating and sometimes provocative, but he writes with insight as well as with a deep sympathy with the social aspirations that so often colour the ideals of students which will commend his book to them, no less than to those responsible for determining the trend and content of university teaching.

Dr. Dunsheath's book from the first point of view gives a fair indication of the structure on which the attempt to obtain quantitative estimates of the future demand for graduates should be based. Here his book is as important to the industrialist as to the appointments boards which attempt to prepare those estimates. Some chapters, indeed, are almost specifically addressed to the industrialist: if there are graduates prejudiced against entering industry there are also industrialists prejudiced against employing graduates in some at least of the fields which Dr. Dunsheath indicates. He gives some attention to the question of the man of science as administrator, and not only here but also in other places he emphasizes the importance of the student taking full advantage of the opportunities which a university offers to broaden his mind and outlook and enlarge his contacts with men and women. All the weight of his experience is thrown against the narrow bookish conception of education, as it is against premature or excessive specialization.

As might be expected in a book of this size, some parts of the wide field are surveyed rather sketchily, and Dr. Dunsheath would be the first to admit that he initiates rather than exhausts either discussion or description. Nevertheless, he has given a fairly clear statement of what is involved in the present discussion on the expansion of the universities, and his book should not be without value to those also who are endeavouring to see that a reasonable balance is achieved between the numbers of university-trained men and women who enter industry and those entering the universities and the public services. For its price, the printing and production might well have been better; its usefulness would be increased if it could be issued in another edition at half the price.

R. BRIGHTMAN

SEA WAVES AND SURF

Wind Waves at Sea, Breakers and Surf

By Henry B. Bigelow and W. T. Edmondson. (United States Navy Department: Hydrographic Office: H.O. Pub. No. 602.) Pp. xii + 177 + 24 plates. (Washington, D.C.: Hydrographic Office and Government Printing Office, 1947.) 2.80 dollars.

SEA WAVES are as unruly as ever; but their characteristics are becoming more predictable as knowledge accumulates. The pioneer work of Arago and Stevenson was energetically extended by the American army engineer Gaillard, whose book on "Wave Action" published in 1904 has recently been reprinted. The aim of theory has always been to extract from the reality simpler ideas that are comprehensible; that real sea waves are complicated is sufficiently evident from the stereophotographs and contour diagrams prepared in 1939 by Schumacher. The first mathematical guess at the nature of a sea wave was made by Gerstner in 1802, and the later theories, most notably those of Stokes and Rayleigh, have provided a sound basis for the work of the physicist and engineer.

The appearance, therefore, of a book by Henry B. Bigelow and W. T. Edmondson is particularly welcome because of the extensive work on waves that has been done since 1940. It is described in the preface as a popular book; but the reader may take notice that it contains too many facts to be easy reading for the landsman. It aims at being a simple comprehensive account of wind waves written for the seafaring man. For this reason it is not a text-book, and the authors present only the general findings of theory supported by numerous practical illustrations taken mainly from the seaboards of North America. This practical bias is very desirable in a science which has such practical applications. The European reader may find difficulty in appreciating the practical examples and applying them to his home waters, unless he is provided with a good atlas of the American lakes and seaboards. The book is illustrated by 57 photographs and diagrams and contains 37 numerical tables with a sufficient number of selected references.

A notable feature of the book is an atlas of the frequency of occurrence of high seas and low seas and of high swells and low swells in all the major oceans during summer and winter. This atlas is one result of the military demands of the Second World War; it may prove to be of value to commerce, since such information is needed in the construction of new harbours and other engineering ventures that are exposed to the sea, as, for example, certain new oilfields. This atlas is the only one available as yet to the public.

The first four chapters describe the character of waves at sea, their growth under wind and their propagation away from the storm as swell. The last three chapters describe how waves change their behaviour when approaching the coast, due to shoaling water, to refraction around islands or headlands or to the effect of tidal streams, and describe the different types of surf which form on various beaches. The complicated effects are rationalized in a pleasing way, and these chapters deserve the attention of all maritime engineers. Though the discussion of theory is avoided, the numerous practical observations will suggest useful lines of work to the specialist. Is the grouping of waves, for example, as fortuitous as it might seem, for if fifty or more successive waves are observed by a ship, could not the next one be predicted with fair certainty? When a moderate swell is partly beaten down by an opposing wind, in what form does it emerge? Is its wavelength increased or diminished or does it merely show a reduced height?

As a correction of fact it may be pointed out that in 1911 Rayleigh deduced that waves would show a small decrease in height as they first approached shallow water, so this is not a recent discovery.

The authors give no space to the description of modern wave-measuring instruments or to techniques such as frequency analysis which are advancing the science. These subjects would find a place in a specialist's text-book, and it is to be hoped that the authors will compile one, since the present book meets its own purpose so well.

N. F. BARBER

FREE RADICALS IN CHEMISTRY

The Chemistry of Free Radicals

By Dr. W. A. Waters. Second edition. Pp. viii + 296. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 20*s*. net.

DURING recent years it has become increasingly evident that free atoms and radicals, chemically very reactive but physically quite stable, play an important part as intermediates in chemical reactions. Thus the equation of a chemical reaction, as usually formulated, is very often merely the sum of many separate equations involving their short-lived substances, and a knowledge of their properties and reactivity is necessary if we are to understand the mechanism of the reaction as a whole. Consequently there has arisen in the last two decades a new kind of chemistry, no longer bound by the usual valency rules—the chemistry of free radicals. Dr. Waters' book surveys in a general way the whole of this rapidly growing subject.

The second edition, which has just been published, is identical in subject-matter with the first, published two years ago, but several minor alterations have been made and references to work published in 1947 are included. The approach to the subject is that of an organic chemist interested in understanding better the well-known reactions of organic synthesis. Physical methods of investigation, such as spectroscopy and mass spectroscopy and the results of theoretical chemists on free radical structure, are therefore omitted, although there is a fairly detailed chapter on the use of magnetic properties of free radicals as a means of diagnosis. After a general and historical introduction on the methods of production and detection, there are chapters on resonance-stabilized radicals of the triphenylmethyl type, the gas reactions of free atoms and the reactions of alkyl and aryl radicals and radicals containing other elements than carbon and hydrogen. These labile molecules are seen to be of common occurrence in a wide variety of chemical reactions. There follows an account of photochemical decompositions and the free radical mechanism of polymerization and oxidation. Finally, the subject is carried into the field of biochemistry, and the free radical mechanisms of biological oxidation are critically discussed.

The book is complementary in many ways to Dr. E. W. R. Steacie's "Atomic and Free Radical Reactions", first published at about the same time. Dr. Steacie is particularly concerned with the kinetics of the reactions of the simple free radicals mostly in the gas phase, and gives a very detailed and comprehensive account of these reactions and their associated activation energies in so far as they are known. Dr. Waters, on the other hand, presents a more general and very readable account of a wider field and devotes more attention to reactions in solution. Each author is therefore writing particularly about that part of the subject to which his own research has contributed much.

Apart from the value to research workers in this relatively new branch of chemistry, Dr. Waters' book will be read with interest by a much wider public who want a general and lucid account of a subject which has applications in so many other branches of chemistry and biochemistry. In particular it will be of great interest to organic chemists in presenting a means of understanding better what are now almost classical methods of organic synthesis and preparation.

The Oxford University Press is to be congratulated on the production of this volume at the sort of price which is becoming rare in scientific literature. It is unfortunate that there is no term in the publishers' vocabulary with a meaning between 'new edition' and 'reprint' or 'new impression', for volumes of this kind which, though technically second editions, are not sufficiently changed to make their purchase necessary by owners of the first. In the absence of such a distinction a second preface or publishers' cover note indicating what changes have been made would be of value.

GEORGE PORTER

STELLAR ASTRONOMY

An Outline of Stellar Astronomy

By Peter Doig. Second edition, completely revised. Pp. vii+168. (London: Hutchinson's Scientific and Technical Publications, 1947.) 10*s*. 6*d*. net.

THIS little book is designed, as the author unassumingly states, for readers who have "slightly more knowledge than that necessary for perusal of 'popular' astronomical literature". It is, in fact, a useful summary, remarkably complete for its size, of the present state of knowledge, and there will be many genuine astronomers, both amateur and professional, who will find it worth reading for the facts and opinions which it reports.

It is not, however, a text-book, and although it does not claim to be one it must be said that it would have been even more useful if it had approached the text-book ideal more closely in some respects. In particular, although the facts, and the conclusions from arguments, are clearly stated, the arguments themselves are frequently so much compressed that they lack clarity; no one, for example, who is not already familiar with Trumpler's work on open clusters and interstellar absorption will be likely to grasp the argument summarized on p. 28. In some places compression has resulted in actual errors; thus it is stated that the v-component of proper motion is caused by the sun's motion, and in the formulæ for mean parallaxes based on the v and τ components no mention is made of the fact that with the former the means are algebraical while with the latter they are arithmetical; also the sign of v is not defined, but appears to be opposite to the usual convention. These two are almost the only formulæ presented in the body of the book, and they are not actually usable as presented.

There are a number of good appendixes, mostly devoted to formulæ; one on indirect methods of parallax determination omits all notice of the three methods dealt with in the book proper, which may mislead some readers. There is a short bibliography at the end of each chapter, but it is quite clear that much more extensive and detailed references could easily have been given; they obviously were used by the author, especially in the appendixes (where scarcely any are quoted), and they would also have been valuable for elucidating the arguments in the text. There are a fair number of printer's errors, but most of these are minor. In spite of such criticisms the book well deserves a place on the shelves of working astronomers, in addition to having obvious value for the readers to whom it is more specifically addressed.

R. D'E. ATKINSON

Atomic Energy Levels as derived from the Analyses of Optical Spectra

Vol. 1, Section 1: The Spectra of Hydrogen, Deuterium, Helium, Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen and Fluorine. By Charlotte E. Moore. (Circular of the National Bureau of Standards, 467.) Pp. iii+75. (Washington, D.C.: Government Printing Office, 1948.) 50 cents.

THIS is apparently the first of a series of reports from the National Bureau of Standards, Washington, and covers the elements of the first row of the Periodic Table. That very valuable book, "Atomic Energy States", by Bacher and Goudsmit, is now sixteen years out of date, and as it is not being revised this new series will eventually replace it.

The general arrangement follows closely that of Bacher and Goudsmit; but it is an improvement to have all spectra treated similarly with the ground-state of the atom taken as zero energy. This part is right up to date, including work up to late in 1947. The recent work of Edlén is fully treated, and many of his hitherto unpublished results are included. It is interesting to see the inclusion of the ^4S level of C I at 33735 cm.$^{-1}$; this has been the subject of much discussion in connexion with the energies of carbon bonds. The introduction to the series has not yet been published, and that is quite understandable; but it is a pity that a brief key is not given to the mysterious symbols (T., G.D., etc.) which appear after the references. The present circular does not contain any diagrams of term schemes; but charts of predicted terms in the spectra of some isoelectronic sequences are promised later. This work of compiling atomic energy-levels is an extremely valuable contribution to science, and these volumes will be indispensable to anyone who uses spectroscopic data.

A. G. G.

Finite Differences and Difference Equations in the Real Domain

By Prof. Tomlinson Fort. Pp. viii + 251. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 25*s.* net.

IN his preface, the author states that this volume includes material for a course in finite differences as well as a treatment of a number of special topics. A selection of material was necessary in order to bring the work within reasonable compass, and also to follow somewhat the special interests of the author. The very large theory of difference equations in the field of analytic functions of a complex variable has been completely omitted. This has carried with it the omission of a variety of related subjects, particularly in infinite series.

The first six chapters constitute a readable account of the applications of the finite calculus to differencing, summation, the polynomials of Bernoulli and Euler, numerical differentiation and integration, and interpolation. The remaining eleven chapters are mainly devoted to a study of the linear recurrence relation, that is to say, the linear difference equation in which the independent variable assumes integral values. It is in this topic that the author's main interest clearly lies, but the powerful and elegant operational methods which are available in this field are barely touched. On the other hand, there are interesting and useful accounts of the linear recurrence relations of the first and second orders with periodic coefficients.

L. M. M.-T.

A Bibliography of Chemical Research in South Africa, 1910–1939

Compiled by Dr. Herbert Coblans. (Published for the Natal University College.) Pp. ix + 25. (Cape Town: *African Bookman*, 1947.) 7*s.* 6*d.*

THE author of this slender volume explains that the lack of bibliographical tools is a real handicap to research workers in South Africa, since the proceedings of the learned societies there have no cumulative indexes. Many of the papers listed, however, have been published in European or American journals, and chemical research is perhaps one of the best abstracted fields of work. The information given can, therefore, be of special interest only to those chemists who wish to know which publications were by South African authors. Full titles of the papers are given and the references to the publications. The classification is according to subjects in decimal order based on the general principle of increasing specialization. In each section, the order is according to year of publication. Dr. Coblans is himself a chemist, and the accuracy of the book may, therefore, be taken for granted. His position as librarian of Natal University College vouches for his bibliographical ability. It is clear from the contents of the book that chemists in South Africa are making notable contributions to research in their subject, as was, in fact, generally realized before its publication.

Studies and Essays presented to R. Courant on his 60th Birthday, January 8, 1948

Pp. viii + 470. (New York and London: Interscience Publishers, Inc., 1948.) 33*s.*

PROF. R. COURANT, formerly of Göttingen and now of New York, who is known to all mathematicians by Courant and Hilbert's "Methoden der Mathematischen Physik", attained his sixtieth birthday on January 8, 1948. To commemorate the occasion a number of his friends and colleagues were invited to contribute articles for a volume to be presented to him. Among the thirty-eight mathematicians who responded to this invitation are included such well-known authorities as Harald Bohr, Carathéodory, Franck, Hadamard, Kramers, Neugebauer, Pólya, and Van der Waerden. The papers cover a wide field, corresponding to the wide range of Courant's own work, and some of them are direct developments from this work. Although most of the authors are foreign, all but six of the papers are in English.

The Cathode Ray Oscillograph in Industry

By Dr. W. Wilson. Third edition, revised. Pp. xii+252. (London: Chapman and Hall, Ltd., 1948.) 18*s.* net.

BECAUSE of demand the present text has been off the market for some time, so the author has taken the opportunity of bringing some of the matter up to date and also of incorporating applications of cathode-ray tubes which have been recently released. Not only would radar have been impossible but also many of the measurements and controls of industry would have been impracticable without the cathode-ray tube. It has become a tool of precision and a means of display. The types available and applicable to special tasks in industry are so well treated by the author that this edition will also soon be disposed of.

L. E. C. H.

THE PASSING WORLD*

By Sir HENRY TIZARD, K.C.B., F.R.S.
President of the British Association

SEVENTY-SIX years have passed since the British Association met in Brighton. Great changes have taken place in the world since then. Nothing illustrates the lapse of time more strikingly than one passage in the address of the president, Dr. William Carpenter. After referring to the expedition sent for the relief of Livingstone he added :

"While we give a cordial welcome to Mr. Stanley, let us glory in the prospect now opening, that England and America will co-operate in that noble object which—far more than the discovery of the Sources of the Nile—our great Traveller has set before himself as his true mission, the Extinction of the Slave Trade."

And nothing better illustrates the truth of the old saying that the more things change the more they remain the same than the address of the president of the Section of Engineering, Mr. Bramwell. He discussed the coal problem. He directed attention to the alarming increase in the cost of coal, which had doubled in a year. "I am aware", he said, "that the subject of coal is a hackneyed one", but the startling facts to which he referred "force us seriously to reflect upon the use and also the abuse of coal." He discussed the inefficiency of domestic fires; but said he would rather put up with the whole of our present domestic discomforts, and even with the loss of heat than resort to the stove as a remedy. "But let not users of coal remain indifferent to savings on their present consumption until those improvements are discovered by scientific men ; on the contrary, let them forthwith do everything in their power to reduce the consumption to the extent to which present science and, in some instances, present practice show the consumption can be reduced."

At the same meeting the famous physiologist, Prof. Burdon Sanderson, referred to the backwardness of physiological research in Britain as compared with Germany. "If a man wants to be a physiologist", he said, "he must, as things at present stand, study medicine. There is no logical reason for this : for although medicine ought to be built on physiology, there is no reason why a physiologist should know anything about the art of curing diseases." However, it was a most encouraging sign of the times that Trinity College, Cambridge, had "condescended to provide a place for physiologists to study and labour in, from which . . . one or two valuable researches have already sprung." We shall all agree that the condescension of Trinity College has been amply rewarded. There is perhaps still room for similar acts of condescension on the part of wealthy corporations.

There is, finally, another passage in Dr. Carpenter's address which is of special interest to me. He describes how he urged on his friends in the Admiralty the importance of organising a new expedition to circumnavigate the world, and how the Royal Society followed up his preliminary inquiries with a formal request. The Admiralty agreed, and the good ship *Challenger* was then fitting out at Sheerness, and being equipped with the most modern scientific apparatus. Captain Nares had been chosen to command the expedition, and Prof. Wyville Thomson to lead the scientific staff. The reason of my special interest is that my father was the navigating officer of that famous ship.

All that the British Association set out to achieve over a hundred years ago has been accomplished. Long past are the days when the public estimation of science had fallen so low that, to use the words of David Brewster in 1830, no scientist enjoyed "the favour of his sovereign, or the friendship of his ministers ;" and when an alarmed Dean of York was moved to publish a pamphlet entitled, "The Bible defended against the British Association", which attained such a popularity with Victorian churchgoers that it ran through five editions in one year. We men of science have little to complain of now. The public estimation of science stands higher than it has ever done in Great Britain. The Royal Society enjoys a prestige unequalled since the early part of the eighteenth century. The Great War, which has been succeeded by an uneasy peace, grimly demonstrated that the country whose rulers neglect science is lost ; and public men in England now display a touching but alarming faith in the power of science to solve any national problem, however serious. The time is near when, as Huxley warned us over sixty years ago, science, like Tarpeia, may be crushed with the weight of rewards bestowed on her. Let us then beware, when all men speak well of us, and be critical of ourselves. Let us ask whether we are claiming too much in some directions, and doing too little in others ; let us consider in fact whether the great forces of science, on the proper exercise of which all social progress depends, are in balance.

The Progress of Sixty Years

It was with some such thoughts as these that I chose the title of my address. It is taken from Dr. Johnson's well-known advice to the poor scholar in the "Vanity of Human Wishes."

> "Deign on the passing world to turn thine eyes,
> And pause awhile from letters to be wise."

I propose to pause awhile from the fashionable discussions of Science and the Community, Science and Education, and the like, and to invite you to turn your eyes on the passing world. For it is passing —from one state of unstable equilibrium to another. I say unstable, for many many years will pass before the dreams of those who look forward to a world Government which will bring not only peace but also happiness to all, will come true. But if it must be in unstable equilibrium for many years to come, let us at least strive to balance it so that the chance of a major catastrophe is made as small as possible. Science has much to contribute to this aim ; but just as no man can aim a rifle accurately without a backsight as well as a foresight, so must we provide ourselves with both, if our contribution is to be worth

* From the Presidential Address, delivered at Brighton, on September 8.

while. The backsight is history; it can be fashioned accurately by study. The foresight can only be fashioned from our knowledge of the state of science as it exists to-day, and from what we know is possible. It cannot be so accurate as we could wish, because we cannot foretell the effect of discoveries of which we have no inkling at present.

My backsight shall not be too far back. In considering the future we shall not gain more by studying remote history than we gain perceptibly in accuracy by lengthening the barrel of a rifle. I shall sight, somewhat arbitrarily, from the year 1885; not 1685. It happens to be a convenient year for me, as it was the year of my birth. It happens, too, that it marks almost the close of the stagnant period of nineteenth century science, when many men thought that "our power to discover new experimental facts was practically exhausted." But new men were coming on, and new ideas were hatching. J. J. Thomson had just been elected to the Cavendish chair of physics at the scandalously young age of twenty-eight—a thing which would not be tolerated nowadays. Charles Parsons had patented the steam turbine in 1884, and demonstrated a model at the Inventions Exhibition in 1885. Gowland Hopkins had been appointed assistant to Sir T. Stevenson, the Home Office analyst, and was studying, in his spare time, the pigments of the wings of butterflies. Three years were to pass before he was able to begin his formal education in science as a medical student at Guy's Hospital. Charles Sherrington was fighting cholera in Spain and investigating its causes, and Rutherford was carrying off all the prizes at school in New Zealand. Of these great men, whom many of us had the privilege of knowing, only one is alive to-day. Sir Charles Sherrington is the oldest living president of the British Association. We send him our respectful and affectionate greetings.

It is understandable that none of these events, which in their different ways were to have a more profound effect on history and society than any legislation, or rise or fall of governments, created any public interest, except perhaps the exhibition of the turbine which was considered ingenious but wholly unpractical. In other respects the events of the year 1885 followed a normal course, judged by modern standards. There was fighting in what we now call the Middle East, which ended in the massacre of British troops, and of their leader, General Gordon. Our Russian friends were told that anxious though we were to preserve our friendship, there was a limit to patience. But the British public soon recovered from the shock of Gordon's death, and refused, so far as I can judge, to be seriously disturbed by the prospect of war. It must be remembered that they were denied the blessings of broadcasting, and other modern equipment for the ready circulation of bad news. They were far more exercised by the prospect of cholera spreading from Spain. They had reason for their anxiety, for the great majority remembered the epidemic of 1866 when 14,000 deaths from cholera were recorded. On the whole, the people of England jogged along in a deplorable state of confidence, which was, however, justified by events, for nearly thirty years of peace followed, broken only by minor wars which had no perceptible effect on the growth of material prosperity.

In 1885, after a few years of depression, during which nearly 700,000 men and women left the country to seek better opportunities overseas, the United Kingdom was still the greatest manufacturing nation of the world. An enthusiastic commentator wrote at the time that "the material greatness of the country is amazing—it exceeds that of any other Empire, Ancient or Modern. But the moral greatness is even grander . . ." Unemployment was sometimes high in particular trades, such as shipbuilding, but between 1885 and 1914 it was never alarming, and was often as low as 2½ per cent of the gainfully employed. The United States were not then serious competitors; imports of iron and steel manufactures from the United States only reached an annual value of £500,000 in 1890, but from then on steadily increased. Germany was considered a more serious competitor. In the pursuit of science she stood first among the nations, and she was applying the methods and results of scientific research to industry on a scale and with a determination that far surpassed her rivals. At the meeting of the British Association in 1885 the president, Playfair, sadly recorded that in science "Oxford and Cambridge are still far behind a second-class German University", and that "in Great Britain we have nothing comparable to the great technical college of Zurich". Germany kept her pre-eminence in applied science until 1914; but it is perhaps worth noting that she never equalled the industrial prosperity of England, judged by the test of real national income. She might have done so, had not her rulers believed that by war they could find a short cut to the happiness and wealth that could have come in the natural course of events to a hard-working and highly educated people anxious to live in peace with the world. The terrible fate of Germany is a tragedy that affects us all, the last act of which perhaps we have not yet witnessed.

Many of the numerous comforts and luxuries which are now within the reach of every diligent working man in England are the result of invention or scientific discovery in or about the year 1885. I have already mentioned the steam turbine, which by making possible the generation of electricity on a large scale provided in the most convenient form the power on which industrial productivity so largely depends. Kelvin lit his house with electricity in 1881, and the telephone was invented in 1876; but they were both scientific curiosities in 1885. The modern 'safety' bicycle first appeared upon the roads in 1885; it was the manufacture of a reliable chain that made it practical. The first Dunlop pneumatic tyre appeared in 1888; but the idea was not then wholly new. Like many other things before and since, it had been invented before its time, that is to say, before manufacturing technique was sufficiently advanced to make it practical. Edison, in 1885, was in the full tide of his inventive genius. The first talking machine had been demonstrated in 1877, and in 1885 he was busy experimenting with motion pictures. Swan, whose share in the production of the carbon lamp is well known, invented a practical process for the manufacture of artificial silk in 1883. The typewriter in its early form was then quite old; but difficulties in manufacture prevented it from becoming available in quantity until towards the end of the century. The internal combustion engine which, in peace and war, has had a greater influence on society than any invention since that of printing, was developed from Otto's experiments in 1877. The intrepid Daimler drove a bicycle powered by an internal combustion engine of his own design in 1885; and the first motor-cars were sold to the public. In the field of applied chemistry one far-reaching development to recall is the electrolytic production

of aluminium in 1885. Aluminium was then a rare metal costing £18 a pound. It now costs 10d. a pound.

Thus, although the science of physics was languishing until the discovery of the electron, X-rays and radioactivity in the closing years of the century, it was a time of enterprise and progress in engineering practice. Britain prospered. In 1897, the year of the spectacular triumph of the *Turbinia* at Spithead, we exported goods to the value of one quarter of everything we produced. Ten years later we shipped overseas nearly one third of the whole national output of goods of all sorts—on farms, in mines, or in factories. If we were doing so to-day we should have little cause for anxiety. Perhaps it was this very prosperity that caused us to fall behind in some branches of industry, for when there is little unemployment and when the standard of living is obviously rising in all sections of the community, there is an excusable tendency for manufacturers to go on doing what they know they can do successfully, rather than to launch out in new directions. Is not this, rather than the neglect of science, the chief reason for the fact that synthetic dyes and fine chemicals were manufactured in Germany, rather than in their original home England? Whatever the answer to this question, the fact remains that when war started in 1914 we were caught off our balance. We found ourselves dependent on our enemies for many essential products and instruments on which our power to make war, and to maintain health, depended. But, to everyone's surprise, we also found that the reserve of scientific ability in the country, though not large, was high enough in quality to overcome the immediate dangers with remarkable speed. Young men from the universities who had spent their time on researches of no practical importance applied themselves with success to problems often completely outside the range of their previous studies. We had the same experience in the Second World War, although fortunately we also had the foresight to prepare for some of the worst dangers beforehand. There is a clear lesson, I feel, to be drawn from this experience. Whatever may be done, in a burst of public enthusiasm, to support and promote schools of research at universities, nothing should be allowed to lower the quality; and size, beyond a certain point, undeniably does. A research laboratory, of whatever nature, is like a living cell. Once it reaches a certain size, which may differ with the nature of the subject, it must divide or die. When a young graduate tells me, as one did recently, that he was going to do research because it got him off military training, it makes me wonder whether we are not already overpopulating the research departments of universities.

The shock caused by the exposure in 1914 of our industrial shortcomings, which had been concealed by the apparent prosperity of previous years, led to a great increase of research by industry and by Government. The National Physical Laboratory, which had been of inestimable value during the War, extended the scope of its work. The Department of Scientific and Industrial Research, which was founded in 1915, established other Government research laboratories, and encouraged the formation of research associations to serve the needs of the older scattered industries. University schools of science were greatly enlarged, and under the influence of the great men of the inter-war period there was a surge of discovery which put Great Britain in the van of progress in nearly all branches of science. We became a scientific nation. The newer industries, such as the viscose and radio industries, which had been founded on science, rapidly developed. The chemical industries took on a new and active lease of life. Germany, badly disorganised by defeat, ceased for many years to be a serious competitor in the world market.

Many of us must have felt confident that when leadership in scientific and industrial research was allied to experience in commerce and manufacture, and to skill in craftsmanship, our country would have little difficulty in maintaining its position among the nations of the world. We have been disappointed. I am referring now not to the acute difficulties of the present day, but to the general trend of events before and after the First World War, when in spite of a nearly continuous advance in national income and standard of living, Great Britain gradually lost her pre-eminent position. We cannot attribute this relative decline to the 1914 War. That War had curiously little effect on our economy. Nor can we attribute it to the world depression in the 1930's. The depression affected us much less than many other nations, for owing to the great fall of prices of food and raw material the terms of trade moved sharply in our favour. During 1930–38 the volume of exports necessary to purchase a given volume of imports was only two thirds of what it had been during 1885–1914. To what then shall we attribute the relative decline? Shall we argue that a main cause was that research was on too small a scale, or shall we seek for other reasons?

Research and Industry

Let us first be clear about what results we expect to come from the application of science to industry. The primary object of industrial research is severely practical. It is not to enlarge the boundaries of knowledge, or to publish scientific papers, although that may be a prerequisite or a consequence. The object is to do something that has never been done before, or to do things better than they have been done before. And it has, or should have, the special object of reducing the labour required to supply the material needs and wants of men. All social progress such as spread of education, promotion of health, opportunities for leisure and healthy recreation, must depend on the power of science and technology to increase the productivity of industry. The rate of social reform is set by the rate at which productivity increases; and social unrest is inevitable if reform lags too far behind the advance of technology, or is pressed too thoughtlessly before it. So we must judge the effect of industrial research not merely by the new comforts and luxuries that it produces, but also by the rate of improvement of existing processes.

In Britain, which depends more than any other country on international trade, and which can continue to maintain its present population only by exchanging manufactured articles for food and raw materials, the productivity of labour is of primary importance, for unless it is as high as, or higher than, in other manufacturing countries, we shall not be able to compete in the markets of the world. And the productivity of labour in Britain is far lower than it could be if the results of past research were more resolutely and continuously applied. We find this particularly in certain industries of great importance. In the coal industry the results are painfully obvious—

ne coal raised per man employed is now lower than was thirty years ago, when nearly all coal was ewed by hand. Research on building has been tensively pursued since the Department of Scientific nd Industrial Research was founded. Those esponsible for its direction have not been content ith the publication of papers giving the results of heir investigations but have built demonstration ouses for other builders to inspect and study. But re better houses now being built with less labour han twenty years ago? I doubt it; if not, the esearch has had as yet little influence on practice. The Shirley Research Institute for the cotton industry s well known for the range and excellence of its ork; but productivity in the cotton textile trades s lower than it was fifteen years ago and much lower han in some other countries. Taking British industry as a whole, productivity is far lower than in the United States. In both countries about 40 per ent of the population is gainfully employed. In the United Kingdom the proportion engaged in manufacturing, building and civil engineering, which overs the production of all capital and consumer oods (other than minerals or food) is now a little ess than 18 per cent of the population. In the United States the corresponding figure is 12 per cent; nd yet in proportion to the population the volume of production is far higher than in the United Kingdom.

The causes of the relative productivity and wealth of nations are, of course, many and complex. We gained our supremacy in the nineteenth century because we excelled in engineering genius and were the first to use mechanical power on the large scale for manufacture and transport. Our population grew rapidly because we were prosperous, and it paid us to become a food importing nation because the productivity of labour in the secondary industries was so much higher than in agriculture. But conditions have changed in the course of time. We no longer have any outstanding natural advantages, and we must expect that given approximately equal skill in technology other nations with greater natural advantages will surpass us. Only by maintaining leadership in the application of science can we hope to keep our position among the great nations. So it is not surprising that the United States, and Canada, for example, with their great natural resources, and abundant supply of cheap power, should have passed us in wealth and productivity before the War. It would have been surprising if they had not. But it is by no means so easy to explain why Switzerland, which in 1885 possessed a national income per head about two thirds of that of the United Kingdom, should have equalled us in prosperity by 1939; or why the industrial productivity of Sweden, a country that has no coal, should have been rising so much more rapidly than ours in the years between the wars. These two countries cannot be said to possess natural resources superior to ours; nor can it be argued that in the quality or quantity of scientific and industrial research they excel us. But I suggest that they, in common with the United States, possess a higher average standard of technology than we do, and have a much greater proportion of men of high scientific education in executive control of industry. I quote them in support of my view that it is not the general expansion of research in Britain that is of first importance for the restoration of its industrial health, and certainly not the expansion of Government research remote from the everyday problems of industry. What is of first importance is to apply what is already known.

The fact is that all really new developments of industry are the product of the work of very few men. In general, knowledge in the physical sciences now accumulates at a rate much faster than it is, or possibly than it can be, applied in industry. There is a vast amount of knowledge waiting to be used. No new discovery, in any field, is likely to have so quick and beneficial an effect on British industry as the application of what is already known. We hear, for example, of the possibility of the production of power from atomic sources of energy. I do not think that anyone will be rash enough to prophesy what discoveries of real industrial importance will result from the researches now in progress; but I shall certainly assert that the production of power from uranium cannot bring such economic benefits to Britain within twenty years as would the practical application of known methods of economizing coal. Mr. Bramwell's advice in 1872 is still sound, and is always likely to be. Even in those fields of industy where science and development have been most in step, we find scientific knowledge far ahead of practice. In aeronautics, for example, research has shown, without any shadow of doubt, that it should be possible to design aircraft far more economical in fuel consumption than present aircraft. For the next step we need bold and highly skilled engineering rather than more fundamental knowledge: if it is successful, air transport, instead of existing precariously on subsidies, will compete on level terms with the train and ship for long-distance passenger travel. Indeed, a revolution in transport is in sight. Shall we leave it to be encompassed by other nations, or shall we show the way? The answer depends on whether we shall encourage enterprise and adventure in engineering.

War as Applied Science

Although I have been interested in the problems of industry for many years, I have never been closely concerned with its conduct. But for much of my working life I have been intimately concerned with that peculiar business called war, which is as old as agriculture, which is subject to the most violent booms and slumps, the cause of which we do not understand, and in which the incentive to succeed is greater than any profit or ideological incentive in civilian life. There is a healthy human rivalry between the various units and companies into which the business is divided. Sometimes it may be thought that this rivalry is carried too far; but all are working for the same cause. In my own life-time I have seen this business change from one in which the practical man considered he had little to learn from scientists, into one in which scientists are concerned with its every aspect, from policy making to the actual conduct of operations. We shall all hope that this business is moribund, and shall do our best to kill it: but in the meanwhile it is possible that other old industries have much to learn by studying the principles of its successful conduct.

In the first place, let us note that the managing directors, the chiefs of staff and commanders, are all carefully selected highly trained professional men, who have gained their experience in a hard school, and who, at intervals in their career, have had the opportunity to study, at staff colleges and elsewhere, the fundamentals of their trade. The managing directors do not have the final responsibility for

policy, but have a great influence on the decisions. Secondly, the technical efficiency of the business is entrusted to a body of engineers and technologists, who have had an advanced specialized education and experience, and who are in personal contact at all levels with scientists who are concerned with research and development. This secures that in all research, however recondite, there is a practical objective, and that there is also a continuous urge to improve in detail. The scientist is primarily responsible for research, but experienced engineers take part in it. The engineer and the scientist are jointly responsible for development. But there is no part in the whole process from research to production and use that is neglected, and none in which scientific thought and influence are wholly absent. One point of special interest is that far more attention—but perhaps still not enough—is given to the study of man in relation to the machines he has to operate than in any branch in industry.

It does not need any profound research to show that the British industries that are now best standing up to the strain of adverse circumstances are those that most nearly approach the system I have described. The chemical industries, for example, have gradually developed a similar organisation over the last thirty years. Neither research nor development has been neglected, and management is in the hands of men highly educated in pure and applied science. The result is that our chemical industries are a source of great and growing strength in peace and war. Forty years ago they were far inferior to the German industries; now they have little to fear from any competitors. In the steel industry, the efforts of which now merit our admiration, it is not uncommon to find management and direction entrusted to men of the highest reputation in science and technology. Turn your eyes on any industry in the world that is similarly organised, on the steel industry of Australia, for example, or the photographic industry of the United States, or the machine-tool industry of Switzerland, and you will find that they are the best able to weather the storms and take advantage of the fair winds of trade. Further, I shall ask you to note that in such industries human troubles, if not entirely absent, are inconspicuous. This, I think, is to be expected, for most men are happiest and do their best work when new things are being attempted, and when adventure of some kind relieves the monotony of a daily routine.

It is a mistake to suppose that science advances rapidly in a war. Certain branches of science may receive a special stimulus; but on the whole the advance of knowledge is slowed. What is striking in a war is the rapid solution of practical problems by the use of previously acquired scientific knowledge and technique. It is a mistake also to attribute this success to the fact that cost does not matter. Cost matters a great deal; indeed the purpose is always to achieve the end in view with the minimum cost of lives, labour and material. Finally, all depends on good design and production. Our weakness in the War was not to be found in the judgment of what was best to do, nor in the scientific work necessary to do it. It was when the stage of design and production was reached that we fell short of the best standards. The magnetron, which contributed more to the success of the Allies than any other single invention, was a product of British science; but it had to be redesigned in the United States for economical manufacture. Penicillin, the greatest practical achievement of medical research during the War, also originated in Britain, but unless American skill in large-scale manufacture had been available, many thousands of men, who now enjoy a healthy life, would have died.

We now see history repeating itself. After the Second World War, as after the First, there is a cry for more research, in industry, and by Government, and a strong demand on the universities to expand their schools of science. Temporarily this enthusiasm is having an unfortunate effect, for the schools are getting starved of teachers; and unless a high standard of teaching is maintained in our schools, the next generation of scientists will suffer. In the long run, too, the expansion of research will fail to produce the hoped-for result unless we promote at the same time education in the higher branches of technology, and unless the technologist takes his rightful place in industry. Throughout the nineteenth century, the advances in engineering that made so great a difference to our prosperity, were the product of inventive rather than of scientific genius. Even the steam turbine, though its conception was founded on long-established physical principles, was brought to a high pitch of practical efficiency with very little assistance from scientists. But we live in a different age. Pure invention still has its place; but industrial prosperity will depend more and more on the continuous application of science to industrial practice. Unless we can raise our standard of technology, unless there are many more men in executive positions in industry whose practical experience has been preceded by a scientific eduction, we shall inevitably fail to keep our place among the great manufacturing nations. President Playfair's remark about Oxford and Cambridge is no longer true. Cambridge has long been recognized throughout the world as a great home of science; and it is not merely devotion to my *Alma Mater* that prompts me to say that Oxford is now not far behind. But I fear that it is still true that in Britain we have nothing comparable to the great technical college in Zurich.

Advances in Public Health

I turn now to another branch of applied science, less spectacular in its results to the ordinary citizen, but far greater in the benefits that it has brought to mankind during the last sixty years. The physical sciences have given men comforts and luxuries that are obvious to all. The aeroplane, the cinema, the broadcasting and television receiver, the domestic refrigerator, and many other familiar things which were unknown even at the end of the nineteenth century, are positive results of scientific research. Health, on the other hand, is in a different category. The ordinary citizen sees little connexion between the advance of science and the fact that he is healthy; it is, he feels, a quality that other people may lack, but is his by right of a superior heredity or habit. Ill health, on the other hand, while a fault in other people, is a misfortune in himself, and a serious reflexion on the state of medical science. How many men now living in Britain have any real conception, I wonder, of the astonishing advances in the prevention and cure of disease that have taken place in the last sixty years, and of how they have come about? Where is the cholera with which I was threatened as a child if I drank unboiled water? Its last appearance in England was in 1893; it was soon stamped out, and there has been no epidemic since. We are puzzled and alarmed by its appearance even in a country like Egypt, with its low standard of sani-

tation. Many other diseases which were common in 1885 have practically disappeared or are under control. Those that remain, will, without doubt, be conquered in the end by the advance of knowledge.

In 1885 the crude death-rate was twenty per thousand; now it is twelve. In 1885 one in every seven children died during the first year of life; now the figure is one in twenty-five. In 1885 a young man of twenty could expect on the average to live for forty-one years; now his expectation of life is forty-eight years. And it is not merely that he will have a longer existence, but that he can look forward to a far healthier life. Where can one now find the stunted children with distorted limbs, who were a common sight in the industrial towns of England when I was young? If it were possible to compare a random sample of young men and women from the poorer districts of London with their grandparents at the same age, it could scarcely be believed that they came from the same stock. Only those few medical men who had the duty of examining recruits for the Army in the First and the Second World Wars can have any vivid appreciation at first hand of the changes that have come about in a single generation through the study of nutrition and preventive medicine.

These great advances have been mainly due to the fundamental researches of very few men, and to the vigour and good judgment with which their work has been extended and applied in practice. Never has public money been better spent than on this branch of applied science; and never has such a small investment yielded such a rich return to the nation. The recently published report of the Medical Research Council, covering the war years 1939–45, is a document of the highest scientific and historic importance which can be read with interest and profit even by laymen who are unfamiliar with the jargon of medical men. In 1939 the Medical Research Council confidently stated that:

"The destructive power of arms will indeed have increased immensely since 1918 if it overshadows the advances in knowledge for the saving of life which modern discovery has placed at the disposal of medical men. If a strict comparison were made between what science has done to increase war mortality and what medical science has done to lessen these lethal effects, there is good reason to believe that the latter would be an easy winner."

Omit the word 'medical' in the last sentence, and I think it will be agreed that no prediction has been more amply justified. Nor should we too quickly assume that new destructive weapons evolved by physical science will in the future reverse the decision. In spite of all the hazards of bombing, the average civilian death-rate during the years of war was lower than it was during the immediately preceding years of peace. The deaths in the fighting services were less than one third of the deaths in the 1914–18 War; and more than 80 per cent of the wounded have been restored to normal life. In spite of all the difficulties caused by the submarine blockade, and the shortage of food, which still persists, we are a healthier nation than we were in 1939. Whether we are as energetic is another question.

Our American allies have the same tale to tell. Four years of hard fighting in Europe and the Pacific caused fewer deaths than in the American Civil War, when the population of the United States was only one fourth of what it is now. It was only in Germany, East Europe and the U.S.S.R. that war counted its victims by millions, and then not through the destructive forces of science, but because of the brutality of human nature at its worst.

Nevertheless, the progress of preventive medicine is giving rise to social changes of great complexity, which will seriously affect the peace and prosperity of the world unless their consequences are studied with care, and their possible evils counteracted by wise and far-sighted action. In all countries which have a high standard of education, such as our own, the rise in population which follows a rapidly decreasing death-rate has been kept in check by a voluntary control of births. As a result the average age of the population has considerably increased, and is increasing; the proportion of the population of England and Wales that is more than sixty-five years of age is now nearly four times as high as it was in 1885. This in itself does not yet present any serious problem, for, as the proportion of children is much less than it was, the proportion capable of productive work, between the ages of fifteen and sixty-five, is actually somewhat higher than in 1885. No fundamental difficulty, from this cause, is likely to arise for many years to come. But the population of the world as a whole is now increasing by 1 per cent a year, and its distribution is such as to make it extremely doubtful whether the supply of food can keep pace, even with the present low standard of nutrition. It is the advance of science that has made this possible. War, pestilence, and famine have kept the population within bounds since the dawn of history. War has ceased to be effective; pestilence is rapidly losing its power; only famine is left as a brake until education takes its place. Is famine inevitable, or will science again come to the rescue, as it has done before? I do not think that the danger of the present position is yet fully realized, in spite of all the work and publications of the United Nations Organisation, and in our country the well-informed debates and warnings of the House of Lords. People remember only too well the apparent over-production of food in the 1930's, and forget, or do not know, that since then the population of the world has increased by some 300 million people.

A single example of what is now happening, and will probably happen on an ever-increasing scale, may help to illustrate the problem. Malaria has always been one of the most potent instruments of population control. It is endemic in most tropical countries. In the Far East it has hitherto been an antagonist more to be feared than the armed forces of an enemy. In the Second World War it was defeated by the controlled use of 'Mepacrine', a German drug, which is being replaced by an even better product of British research. In addition, the potential importance of the insecticide D.D.T. for the elimination of malaria-carrying mosquitoes began to be recognized toward the end of the War.

In 1944, Sir Robert Robinson, Prof. J. L. Simonsen, and Dr. Harold King visited British Guiana on a special mission. British Guiana has a population of roughly 400,000. Accurate statistics of the fluctuation of population do not exist; but it is probable that it has remained stationary for the last twenty years. Two thirds of the population used to live under conditions of severe endemic malaria. The birth-rate was low, and the infantile and adult mortality high.

The particular type of mosquito which is the carrier of malaria, and also of yellow fever and filariasis in

the Colony, lives and breeds in the wooden houses, and not in swamps. It is thus peculiarly susceptible to attack by insecticides. The British mission advised a comprehensive trial. They were fortunate in finding a most experienced and progressive officer in Dr. Giglioli, honorary Government malariologist. Their advice was taken; operations were started in 1945, and at the time of speaking it is probable that the whole population of the Colony has been protected. The annual cost of keeping the whole district under continuous control is of the order of five shillings a head.

Malaria is now rapidly disappearing from the Colony. I cannot quote valid statistics covering the whole population; but I have been supplied with exact information about a suburb of Georgetown with a population of about 3,000, and there is no reason to suppose that the results will not apply generally. In this village the death-rate was equal to the birth-rate during the years 1938–44 inclusive. The average infantile mortality during this period was about 250 in a thousand. It rose to more than 350 in 1944. D.D.T. control was introduced in July 1945. By the end of 1947 the birth-rate had doubled, and the infantile mortality had dropped to 67 in a thousand. The population is increasing by 10 per cent annually.

Population and Food Supplies

As the new methods of preventive medicine spread—and that there will be many more to come no one can doubt—we must expect the world population to grow at an even faster rate than it has done in our life-time, unless famine intervenes. Moreover, it will grow particularly in parts of the world that already have a high density of population, such as India, where the population is now increasing by five million people a year; and Egypt, where there are already 2,000 people to every square mile of cultivated land, and where it pays to have children as they are a source of labour and of profit to their parents at a very early age.

Exactly fifty years have passed since a president of the British Association last warned his audience of the danger of famine. Sir William Crookes was then alarmed at the prospective shortage of wheat. He produced evidence to support his conviction that England and all civilized nations stood "in deadly peril of not having enough to eat". But he qualified his gloomy forebodings by the statement that the chemist must come to the rescue of the threatened communities, and went on to discuss the possibility of the fixation of atmospheric nitrogen. If that were achieved, the future, said Crookes, could take care of itself, and "in days to come when the demand may again overtake supply, we may safely leave our successors to grapple with the stupendous food problem". The chemist did come to the rescue, and the plant breeder too, though not quite in the way that Crookes imagined; and now the day has came when we must grapple again with the problem. We must not encourage the easy thought that some entirely new development in science will solve it quickly; there is nothing in sight comparable with the importance of synthetic fertilizers. There are certainly some interesting investigations in progress, for example, the production of food yeasts from molasses, and of fats by the action of micro-organisms on carbohydrates. All that can reasonably be said about these new developments at present is that they show the need for fundamental research in an almost untouched field. They are very unlikely to lead to a new and substantial source of supply of food within the next thirty years. So far as Great Britain is concerned, we must plan our economy on the assumption that food will be both scarce and dear for many years to come. Its scarcity is obvious to us; its dearness is concealed by a policy of subsidies. I do not criticize the policy. I refer to it only because it tends to hide a state of affairs that should be realized by every thinking man.

One or two years of good harvests in the wheat-producing countries may go far to relieve the present troubles of Europe, and will be of great benefit to us. But the supply of wheat is only part of a larger problem. World food supply will only keep up with demand if the productivity of land is increased, and more land is brought into cultivation. The productivity of land in the United Kingdom is already high; much higher, for example, than in most European countries and in North America. The productivity of labour on the land has increased in recent years much more than the productivity of labour in any other old industry. One man working on the land now produces enough food for twenty-five of the population. New Zealand surpasses all other countries in both respects. It is a land blessed by Nature and improved by science. But few people realize that in our small country we now grow enough food for twice the population of Canada. There is still room for a great advance. There is a consensus of opinion among experts whom I have consulted that the production of food in the United Kingdom could be raised by 20 per cent within five years by a combination of measures, such as the improvement of grasslands, the conservation of grass for winter feeding, the control of pests and weeds, the extended use of fertilizers, and the development of large tracts of marginal land such as exist in the Highlands of Scotland. It is argued that, though this would need considerable capital expenditure, there is no direction in which capital expenditure would yield more certain dividends to the nation, or make a more substantial contribution to the balance of trade.

I find these views convincing. But even if all this were to come to pass, we shall still need to import food for twenty to twenty-five million people unless there is to be a large outward movement of population; and we must not lose sight of the fact that at least twenty million people are added to the population of the world every year, and that it is conceivable that in another seventy years, or even less, the world population will have doubled. Whatever other countries may do, it is our bounden duty, and the only certain way of safeguarding our future so long as we remain a large food-importing country, to develop our colonial territories, particularly the underpopulated African colonies, where the increase in population that would follow the control of disease and the increase of food supply would open fresh markets for international trade. This great task will call for the intensive application of science, in collaboration with other countries. The tale of plant disease in our Colonies, for example, is a sorry one. I shall predict that unless the prevention of disease among plants and animals, and all other scientific problems of the supply of food, are studied on the same kind of scale, by men of similar calibre, as are the problems of human health, chaos and misery will result. Whatever new comforts and luxuries may be provided in future by the advance of physical science, it is on the development of the biological

sciences that the peace and prosperity of the world will largely depend. Until recently there have been far too few careers open to young biologists outside the field of the medical sciences. There has been nothing corresponding to the Colonial Service, which has offered to young administrators a life of adventure nicely seasoned with economic security. All members of the British Association will therefore welcome the intention of the Government to inaugurate a Colonial Scientific Service, and will hope that the conditions of service will be such as to attract young men of the highest quality.

Challenge of the Times

We live, indeed, in difficult times. But they are very interesting times; and difficulties are bracing to a nation which has not lost the resilience of youth. We must not get into the way of thinking of our great country as an elderly man who is told by his doctor that if he is very careful of his diet, and avoids all exertion and worry, he may look forward to some years of placid life before he dies. This is a time for adventure; for taking risks. Calculated risks, of course; but not so nicely or so lengthily calculated that they are taken too late. My contacts with universities and with industry are not now so frequent or so close as I should like them to be; but they are enough to convince me that the spirit of adventure in science is as lively as it ever was. It is that spirit which will largely determine the future. Many years hence, when a president of the British Association reviews the progress of the nation from the depths of bankruptcy to new and unsurpassed heights of prosperity and influence, he may well have occasion to refer, as I did at the beginning of this address, to the great influence of the work of a few young men who are now unknown to the public; and he may justly claim that the chief cause of the change was that we had found the right way to combine originality in science with enterprise and speed in its application.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

RECENT ADVANCES IN THE STUDY OF THE CRYSTALLINE STATE

IN his presidential address to Section A (Mathematics and Physics), Sir Lawrence Bragg points out that X-ray analysis of crystals may be said to have attained its majority this year. Its importance has been recognized by the formation of an International Union of Crystallography, and it takes its place with the other branches of science which have unions of their own. Laue discovered the diffraction of X-rays by crystals in 1911; now most universities have an active centre devoted to the investigation of the arrangement of atoms in matter by means of X-ray diffraction. Sir Lawrence has worked in this field from the beginning, and takes the opportunity which this address affords to review what has been accomplished in little more than a generation. X-ray analysis is a typical border-line subject. Its successes are interesting to the chemist, mineralogist, metallurgist and biologist as well as to the physicist, and this is perhaps its most attractive feature.

In X-ray analysis in general, we are seeking to interpret the manner in which a substance diffracts X-rays owing to the spatial arrangement of its atoms. Two main lines of work may be distinguished. On one hand, there is the analysis of the pattern of the perfect crystal, where the atoms have taken up positions of equilibrium under the influence of the interatomic forces; from the conformation of the structure we can gain a deep insight into the nature of these forces. This study is principally of interest to the chemist, because it presents him with a scale plan of the chemical molecule and of the way molecules or ions are held together by the intermolecular forces to form a solid structure. The results of X-ray analysis have had a profound influence on chemistry and mineralogy and solved many problems. A steady advance has been made in tackling more and more complex molecules, and a stage has already been reached where such compounds as the sugars, strychnine, sterols and penicillin can be analysed, to take a few examples. We would like to pass on to the study of such high complexes as the molecules which form part of living matter—nucleic acids, proteins and others.

The other side of X-ray analysis is concerned with what we might call the 'geography' of atomic arrangement in matter. The perfect crystal is an ideal which is rarely attained. Even if the substance is pure it is composed of a mass of crystals, and we are interested in the size and shape of the crystallites and their growth, in allotropic change, and in their preferred orientation and state of strain after mechanical treatment; if complex, we are interested in the fitting together of the crystallites of different kinds. Metastable structures often exist in which there is partial separation into regions of different composition, while a continuous crystal lattice is preserved though in a distorted form, as in the permanent magnet alloys, in martensite, or in age-hardening alloys. We can study the distortion of the lattice by the thermal waves at high temperatures. Amorphous and semi-crystalline matter can be examined. All these aspects of structure are of prime interest to the physicist and metallurgist. They are vitally interesting to the technologist, because the geography of the structure has a profound influence upon its mechanical, electrical and magnetic properties.

In this address, Sir Lawrence reviews the active centres carrying out X-ray investigations in Great Britain; examples are given of recent work, presenting a picture of what has already been achieved, and indicating the lines of exploration which are now being pursued.

SPECIALIZATION AND CULTURE IN CHEMISTRY

PROF. JOHN READ, president of Section B (Chemistry), deals with some of the problems of increasing specialization in chemistry. The growing burden of new knowledge in chemistry, as in science generally, has created many new problems for the student, teacher and research worker. These problems are largely bound up with the growth of

specialization. A fundamental problem confronting the chemist is that of acquiring a proper education leading to a cultured outlook and fitting him to take his place in the world of men and affairs. What steps can be taken to combat the narrowing outlook which threatens to affect science students at all levels, and to provide for their social, cultural and spiritual needs?

Formerly a chemistry student was trained to become an all-round practitioner of his art; but latterly the vision of the student and research worker has narrowed. We have entered into an age of team-work. Chemical science has been aided nobly by such work; but the individual worker is liable to sacrifice a great deal in the process.

The mental effect of an unrelieved absorption in a specialized field of science has been vividly described by Charles Darwin, and the growth of such specialization in later times has led to many criticisms of its effect upon the human subject.

It is in the schools that we view the education of the incipient scientific worker in its broadest aspect; and it is here, helped in the ideal case by home influences, that the foundations of the necessary wider interests must be firmly laid. There ought to be no sense of antagonism between arts and science, and any form of modern education should be made up of a proper blend of each. A lively interest in literature, history, art, music or the drama, gained in early life and nurtured thereafter, would do much to solve some of the problems of specialization in science. Highly specialized teaching in science ought to be avoided in the schools.

In the universities, the way of teaching chemistry is of the first importance. Although his chemical studies must deepen rather than broaden as the student passes onwards towards research, he should always be encouraged to realize that there are a chemical geography and a chemical history, and that these offer him avenues leading to a wider horizon. Chemistry itself may become a cultural and humanistic instrument of high value. Historical chemistry is linked in turn with philosophy, literature, art, and even with music. During the student's undergraduate days a great deal could be done to arm him against the dangers of specialization, and more importance should be attached to the technique of teaching from this point of view.

During postgraduate research work the student should be encouraged to undertake a certain amount of teaching work in the junior laboratories. He should also use opportunities to migrate to new research centres either at home or abroad. A research theme of a suitable kind ought to help the student to become resourceful and to develop originality of thought, besides stimulating his imaginative and critical powers; unfortunately, research themes often fail to fulfil these requirements. Finally, the proper education and training of the young scientific worker, with the application of the various influences that have been mentioned, including personal contact with his teachers, call for the provision of adequate staff and accommodation.

GEOLOGY TO-DAY AND TO-MORROW

THE theme of Dr. A. E. Trueman's presidential address to Section C (Geology) is the future of geology. At the present time, he points out, geology is passing through a period of very active growth. It is doubtful if at any time since the 'heroic age' of the science, a hundred and fifty years ago, there has been so rapid an increase in our knowledge of earth history. More geologists are professionally employed in all parts of the world; many more fields of human activity are dependent on the success of their operations than ever before. They search for ores, coal, oil and water. If in the future we are to depend on atomic energy for some of our power, it will need geologists to locate the new materials. Inevitably, we shall be driven to exploit mineral resources occurring at greater depths, or of poorer quality; while we continue to use materials from the earth's crust the geologist will have an increasing part to play in their discovery. In the course of these explorations much new information is being gathered, but many major problems still await solution.

Although geology is in this phase of active development, its results and methods are probably less familiar to the educated public in Britain than those of any of the other fundamental sciences. This widespread unawareness of geology, which is not found in most other countries, is in marked contrast with the position of fifty to a hundred years ago and calls for serious attention, for it cannot be held that any science is in a healthy condition if its work is insufficiently understood by laymen. The absence of almost any geology teaching in schools and the scarcity of teachers with any acquaintance with the subject are partly responsible for present conditions. It is claimed that geology should form part of a wide cultural education; it can serve as a link between science and more humane studies or as a basis for a new type of synthesis.

Fortunately, the comparative lack of public interest in geology has not in recent years limited the recognition of its value by Government. Much has happened to stimulate the demand for geological advice for a variety of economic purposes, both in Britain and overseas. In the limited area of Great Britain, the Geological Survey, founded more than a hundred years ago, not only meets new demands for more detailed maps but also is required to undertake great new responsibilities. The record of its work in war years, recently published, exemplifies the wide range of activities in which geological information is necessary; in view of the growing importance of the work of the Survey, the need for an expansion of its numbers has been recognized. The Colonial surveys, even more in need of increased support, are accepted as having a vital part in the economic development of the Colonial territories. The present Secretary of State for the Colonies has himself on several occasions appealed to young men to take up the work of geologists in these areas. The small surveys of the past have been sparsely staffed, one geologist being responsible for thirty times the area for which a member of the home survey was responsible. In the past, several Colonial geological surveys have paid for their own cost many times over by discoveries of diamonds and ores, but future results must not be judged only in terms of exportable minerals; more bulky materials, such as limestones, clays, road materials and especially water, may contribute even more to the development of the territories. Alongside these developments of geological survey activity throughout the Commonwealth, the promotion of researches by unofficial geologists is equally essential.

In the immediate future we must expect an increasing tendency to specialization in limited fields and particularly on the fringes of the subject, as on

the borderlines between geology and physics, or geology and chemistry. Advances in such fields as geophysics call for workers with more extensive training in the two subjects. The co-operation of geophysicist and geologist makes possible the interpretation of concealed structures: England south from the Wash requires special study in view of the possibilities of new coalfields. But on a wider front we may expect to learn more of submarine areas, of the structure and origin of mountains and of the larger features of the earth. Work in geochemistry, in the distribution of minerals, the origin of rocks and the nature of clays, promises rapid development. In the fields of geomorphology the problems are barely touched; in palæontology the existing data only serve to illustrate the extent of the problems to be solved. But in all these extensions of knowledge it may be hoped that it will be possible to avoid the isolation of the fields of study, relating them all to stratigraphy and the study of the structure of the earth's crust which form the 'heart of geology'.

TEACHING ZOOLOGY IN THE UNIVERSITY

PROF. H. GRAHAM CANNON discusses "Undergraduate Zoology" in his presidential address to Section D (Zoology). After the First World War, he says, the interest in zoology became almost exclusively experimental. The more orthodox attitude of comparative anatomy became the one to be avoided. This was due to a variety of reasons, but largely because, for generations, zoologists had been teaching the comparative anatomy of dead animals without worrying about how these animals lived. As a result of this changed outlook between the two World Wars, a generation of teachers has grown up who are predominantly experimentalists, and our present undergraduates run the risk of becoming very knowledgeable about the latest developments of experimental technique while knowing very little indeed about the anatomy of the animals on which they work. Recently, but somewhat tardily, it has become recognized that there is such an aspect of zoology as functional morphology, that is, a method of treatment where structures are dealt with not merely in the way in which they are built, but also, and at the same time, from the way in which they function. It is this attitude which should form the basis of undergraduate zoology.

Two main difficulties present themselves in considering the teaching of zoology to undergraduates. First, there is the modern tendency to scorn any elementary teaching and to thrust the first year's university work back on to the schools. This misguided attitude may be excusable in the more basic physical sciences and mathematics; but in the biological sciences, which, after all, utilize the physical sciences as their tools, it is completely illogical. Moreover, it is essential that the more experienced teachers, preferably the professor, should always deal with this fundamental first year's introduction to university study.

Secondly, there is the tendency almost everywhere to introduce specialist courses into the undergraduate years: a tendency which is being encouraged by the efforts of the University Grants Committee to foster the establishment of readerships or even chairs in the most abstruse specialist aspects of biology. At the undergraduate stage the students are quite unable to assimilate such courses. The sort of courses which are being established are those admirably suited for the second part of the Cambridge Tripos. But what is almost invariably overlooked is that the second part is entirely a postgraduate course. The honours degree is given on the first part of the Tripos, and this corresponds to the degrees in the 'Redbrick Universities' of honours general science. It is suggested that it would be a great advantage in all 'Redbrick Universities' to abolish the specialist honours degree altogether and insist on a first degree being taken in general science as at Cambridge. The more specialist attitude to the subject could then be left to a postgraduate year, leading preferably to a master's degree.

SOCIAL GEOGRAPHY

IN his presidential address to Section E (Geography), Lord Rennell of Rodd deals with the geographical environment of man as a social animal, and consequently does not attempt to consider the geographical circumstances of the origin of human species or prehistoric man. But the spiritual as well as the material consequences of geography on human society are considered rather by posing a series of questions, and stating a number of problems, especially in connexion with Africa, than by proposing conclusions or solutions.

Starting from the influence of geography on the spiritual as well as on the material development of society, Lord Rennell makes a strong plea, which he takes up again at the end of the address, for the teaching of geography in medium and higher education as a means of creating a bridge between the humanities and the natural sciences, which "except among the leaders of the latter group" have more and more tended to develop on independent lines divorced from each other. This tendency he dates from the decline in classical education; but he sees in geography, and especially in social geography, a new link which could be made between the two, in view of the manifold contacts which geography has with both the exact and the abstract realms of human thought.

From this point he goes on to discuss a number of problems arising in Africa. What are the reasons why Islam spread as far as the southern rim of the North African deserts but never affected the population south of the northern fringe of the forest belt? Why was the negro and negroid population of Africa antagonistic to outside civilization in spite of many opportunities of contact with more civilized people from Greek and Carthaginian times through all the period of Arab and Portuguese navigation until the European conquest? Why then, and only then, did a ferment of Western civilization begin, within say the last seventy years? Yet the civilizing influence of the Mediterranean found no difficulty in crossing the Sahara and following up the Niles until they came to a dead end against the unwillingness of the negro to adopt or adapt. Why is there no trace of writing or even ideography in Dark Africa? Why was there no true architecture, the wheel or the plough in Africa south of the deserts until the conquering European started the modern phase?

Lord Rennell goes on to discuss the anomalous and absurd consequences of the European conquest, the purpose of which, in spite of Lord Hailey's investigations, remains very obscure. He refers to

the ribbon development of colonies along the coastal routes, and the strange efforts of our Colonial Office to keep separate, contiguous British territories in eastern Africa, in spite of departing substantially in recent years from the dual mandate principle in favour of "colonies d'exploitation". He concludes with the suggestion that only the geographer with a foot in each of the camps tenanted by the humanist and the natural scientist, is fitted to seek answers to the problems he raises, and is unbiased enough to propose solutions which it is incumbent on European nations generally, and ourselves in particular, to find, in order "for the sake of our own good name" to remedy the administrative and social chaos which is Africa.

THE PRICE SYSTEM

IN his presidential address to Section F (Economics), Sir Hubert Henderson remarks that the idea of a return to the price system which is widely advocated to-day is marked by the same defects that marred the idea of economic planning which was so popular a year or two ago, namely, incoherence and wishful thinking.

In its most general sense, the price system is an inevitable outcome of the use of money. So long as goods and services are bought and sold for money, there must be prices; and these prices must always exert a powerful and pervasive influence. It is important, therefore, that this influence should be a healthy one, that the configuration of prices should be such as to pull in directions which accord with the public interest. We want price relations that are right, so far as that object is attainable. But we must be careful not to beg a major question. In the matter of price relations, as in many others, it is easier to be sure that certain things are wrong than to know at all precisely what is right.

According to current price system ideology, the right price is the theoretical equilibrium price. In times of large-scale economic maladjustments, however, this concept is ambiguous. The theory of value comprises two parts, short-term and long-term, each with its appropriate equilibrium price. These prices are seldom far apart in ordinary times, when the economic system has not been subjected to any recent large disturbance. But they are apt to diverge widely when the maladjustments to be corrected are very large. It is a mistake to suppose that in such conditions the theoretical short-term equilibrium price is either what we want, or what we normally get in a free economy. There are apt to be serious and injurious anomalies in price relations when shortages are widespread.

Shortages, or surpluses, are, of course, most widespread, and the consequential anomalies most serious, when there is a large maladjustment between aggregate demand and aggregate supply. It is therefore especially important to avoid disequilibrium here. In Great Britain at the present time it is rightly a main object of policy to remove the inflationary trend in our economy. Success in this might enable us to dispense with many of the controls that irk us to-day, and to simplify others. But it would not enable us to remove them all. The regulation of long-term capital expenditure would still be desirable for a fairly considerable time, and the regulation of imports indispensable for a much longer time.

If the consuming public were free to choose, there is no reason for supposing that imported goods would represent a smaller fraction of their total purchases than before the War. Since our total rate of consumption is at about the pre-war level, this would imply imports at about the pre-war level; or an increase of more than one quarter in our present import-bill. The removal of every vestige of inflation in our internal economy, though helpful, could not radically alter this result. With a huge deficit in our current balance of payments, we are in no position to contemplate a largely increased expenditure on imports.

Price system ideologues believe that disequilibria in the balance of payments can always be corrected by variations in foreign exchange-rates. This belief is attributable to the pivotal role which they assign to the concept of equilibrium price. When, however, our import–export balance is so far from adjustment, there is a huge divergence between the short-term equilibrium rates of exchange and the long-term norm represented by purchasing-power parity. It might be disastrous to try to make our actual exchange-rates approximate to the former. It is better to keep them in the neighbourhood of purchasing-power parity; and to recognize that it will remain essential to regulate the volume of our import purchases as effectively as we now do by means of import restrictions.

More generally, the time-honoured theory of value endorses, and indeed enjoins, the humdrum practical proposition that, when large adjustments have to be made, regulation and deliberate direction may be useful or even indispensable.

THE YOUNG ENGINEER

IN the presidential address to Section G (Engineering), Wing-Commander T. R. Cave-Browne-Cave deals with the qualifications and personal qualities necessary in 'the young engineer', and treats the problem of engineering education from an unusual point of view because his experience has been in the application of engineering science to a wide variety of new developments, mainly in connexion with airships and aircraft engines. Since going to University College, Southampton, he has been dealing not only with students preparing for the external degree of the University of London, but also with apprentices following part-time courses for national certificates and still more practical qualifications. The review is based upon the knowledge and personal qualities which a young engineer should have acquired shortly after the end of his formal training, say at the age of twenty-eight to thirty, and may serve as a guide to those who are considering engineering as a career. It may also be taken as a background against which the various stages of engineering education are examined.

Mathematics is a limiting factor in the progress of a student along the main road of engineering science. It must, therefore, be of a really appropriate type and no harder than is necessary for each corresponding stage.

The general structure of engineering education should be revised so that it is possible for candidates to enter at any appropriate stage. Changes from one course to a more suitable one should be simpler than at present, and there must be fewer 'casualties' who fall out and go no further. Courses of instruction should be aimed, not at a final examination, but at the future useful application of the knowledge acquired.

The student must develop the art of learning by himself from books, because he will have to acquire in this way a great deal more science and technology than can be included in his formal training. If this is achieved, the present overcrowded syllabuses can be shortened by leaving certain parts for subsequent study when required.

Attention is directed to the importance of developing skill in clear explanation of technical matters, both in verbal discussion and in writing. The effective value of a proposal depends not only upon its technical merit but also upon the clarity with which it is communicated.

It is suggested that national service for students who are to read for a degree should be taken between the intermediate examination and Part I of the final degree examination, and that the fighting services should arrange this year to give, in addition to military training, a good practical groundwork similar to that given in the first year of service technical training. The year of national service would then be a valuable addition to the degree course as well as a foundation for future war service, if required.

Personal qualities, judgment, effectiveness, enterprise and determination are so important that they must be considered in the selection of a candidate and must be developed throughout his training.

The address is intended to open a general discussion on engineering education, relating it definitely to the knowledge and qualities which experience shows to be desirable in later engineering work. It contains much new and possibly contentious matter, which, with the discussion on it, should form a useful contribution to the developments which now have to be made in engineering education at all levels.

INVESTIGATION OF FOLK-LIFE IN BRITAIN AND ABROAD

MR. R. U. SAYCE discusses folk-life in his presidential address to Section H (Anthropology). Until about 1914, Britain occupied a well-recognized place in the front rank of folk studies; but since that time it has been falling further and further behind, and appears to a great extent to have lost touch with the developments that have taken place in European countries. A few scholars continue to produce work of distinction; but they lack a common meeting ground, where adequate discussion can stimulate thought and help them to see their special problems in relation to the whole. There are even societies devoted to dialects and place-names, beliefs and customs, dance and song, which have scarcely any contact with one another, although they are all concerned with the culture of the folk. In spite of this fragmentation, we are realizing, as general ethnologists have already done, that a culture must be studied as a whole. This, of course, makes our studies more complex, but also far more interesting. It also needs special training; the student of folk-life must know something of the methods of, and the results achieved by, archæology, history, psychology, anthropology, to say nothing about architecture, agriculture, technology, etc. There can be little doubt that the present unsatisfactory state of British studies in this field is due largely to the failure of the universities to provide the necessary training.

Folk-culture is very closely related to ethnology and to history, and could only neglect one of these indispensable allies at great loss to itself. For many years it has enjoyed close contact with ethnology, to which it is greatly indebted; but it has neglected its second essential partner, so much so that it has been in danger of becoming an unimportant appendage of the former. Nevertheless, a very slight knowledge of our problems is sufficient to make it clear that their solution depends on a historical approach. The subject does not consist of an inert mass of survivals from a vague and generalized past. The contents and their vitality change. Sometimes customs and beliefs appear to survive only in remote circles or among the least educated, and these periods may be succeeded by others when irrational ideas spread rapidly and become widely current. We can see fluctuations of this kind in western European civilization as well as in that of ancient Greece.

The impression must not be given that folk-culture deals only with 'primitive thought' and superstition; it includes the whole way of life of the people—their houses, clothes, food, work, and recreations. All these change, sometimes abruptly, at other times almost imperceptibly; old elements drop out, and new ones come in. For a knowledge of the changes we have to turn to a much closer co-operation with historians and archæologists.

At the present time, certain long-established interpretations of European folk customs are being challenged. A new school of folklorists questions whether the old harvest customs, for example, had any connexion with beliefs in vegetation spirits, and suggests that scholars like Maunhardt and Frazer made insufficient allowance for the spirit of jollity and of competition that would be quite natural where young men and women are for the time working together in the fields. The new school recommends a more modern, functional approach to the problems. There is very much of interest in their arguments, but the question is essentially a historical one. What did the medieval peasant think about the powers that influenced growth and fertility? Did he hold animistic beliefs, or was the hare that dashed out of the last standing corn nothing more than a hare? Until we can answer such questions, it would be as dangerous to apply ideas derived from studies of harvesters during the last century or two to their forerunners of a thousand or two thousand years ago as it would be to accept a modern educated African as a guide to the conceptions and emotions that underlie the age-old tribal customs.

In conclusion, Mr. Sayce makes a strong appeal for properly trained workers in Britain, and for the fullest possible intercourse with scholars in those countries where studies of folk-life have made so much more progress in recent years than they have done in Great Britain.

RECENT ADVANCES IN COLOUR VISION

IN his presidential address to Section I (Physiology), Prof. H. Hartridge discusses recent views on the mechanism of colour vision. Colour vision to-day, he says, is in a situation not very different from that of nutrition half a century ago. The solid constituents of the diet—the proteins, the fats and the carbohydrates—were well known and understood. All major problems concerning them had been solved and there was really little more to be found out about them. Then suddenly the importance of the accessory food factors, the vitamins, began to be disclosed. Sub-

stances, small in amount, became of prime importance in dietetics, and we know to-day how much our health and well-being depend on these accessory food substances.

Atomic physics might be taken as a second example of a branch of science where not many years ago all problems appeared to have been solved and everything to be known. We have only to look back at the last thirty years to realize how very limited our outlook really was in those days.

Human colour perception to-day is in a similar situation, because, until quite recently, most—if not all—known visual phenomena were adequately accounted for either on the three-colour theory of Thomas Young or on the four-colour theory of Ewald Hering. But we are beginning to suspect that things are not quite so simple as they seemed and that there may be present in the human retina certain accessory receptor mechanisms, not embraced by either of these theories, which, however, play an important part in man's colour sense. The questions which now confront us are similar to those which claimed the attention of the early workers on the vitamins.

So far as present evidence goes, there appear to be four additional types of receptor, three of which have a single maximum of activity in the spectrum, which is situated in the yellow, in the blue-green or in the blue. The fourth has two regions of activity: in the extreme red and in the extreme violet; and for this reason may be referred to as 'the crimson receptor' mechanism. These four accessory mechanisms, which play a relatively unimportant part in foveal vision at medium visual angles and at medium light intensities, hold a very different position when these conditions are departed from. Thus in the dichromatic zone of the retinal periphery, at medium light intensities and at the fovea at very high intensities, two of these subsidiary receptor systems, the yellow and the blue, hold a predominant position. On the other hand, at very low light intensities and at very small visual angles, the two receptor types which are most strongly represented are the crimson and the blue-green.

While nearly every phase of human colour perception, when closely examined, discloses evidence of the presence of these supplementary receptors, the idea that there are four of them, or that they have the properties preliminarily assigned to them, may have to be modified in important respects as additional knowledge is acquired.

Lessons of a valuable kind are to be learned from a study of the history of the vitamins; because, whereas only a few years ago a few appeared to suffice, we now have overwhelming evidence that there are many. So it may be with the visual receptors. At this juncture the important point is for us to recognize that accessory receptors are present in the human retina, and then to concentrate attention on the wider problems which their presence involves.

PRESENT-DAY TRENDS IN BRITISH PSYCHOLOGY

PROF. REX KNIGHT, in his presidential address to Section J, remarks that more than sixty years have now passed since the "Encyclopædia Britannica" first published in 1886 Ward's famous article on "Psychology", which William James at once described as "marking the transition of British psychology from one epoch to another". Ward's article showed that psychology was no longer to be regarded as a branch of analytic or speculative philosophy, but as a positive science concerned with the systematic investigation of matters of fact. Since it appeared, striking changes have occurred in the scope, methods and practical usefulness of psychology in Great Britain.

In scope, there have been five major developments. First, physiological psychology, which everyone except Bain neglected in the 'eighties, has come into its own. This has been due to the advocacy of Sully and James, the general acceptance of the evolutionary theory, the researches of neurologists like Lashley and Sherrington, and the influence of the behaviourists.

Secondly, psychology is no longer preoccupied with cognition. The work of James, McDougall and Freud has developed an intense interest in dynamic psychology, and at least as much attention is now given to the conscious and unconscious motives that underlie thought and behaviour as to the processes which are involved in the acquisition of knowledge itself.

Thirdly, sixty years ago psychologists concerned themselves mainly with human beings, and with human beings who were adult, civilized and normal. Now animal psychology, child psychology, anthropological psychology and abnormal psychology are all prominent features of the psychological landscape, and are receiving much attention.

Fourthly, psychology was generally regarded in 1886 as the study of man as an isolated individual, whereas present-day psychology is much concerned with man as a member of society.

Fifthly, the last sixty years have seen the development of mental tests, which, though originated by Galton before Ward's article appeared in the "Encyclopædia Britannica", have been developed during the present century in Britain chiefly by Spearman, Thomson and Burt.

In method, there have also been five notable changes. First, introspection, which dominated the field in 1886, has been supplemented by observation of behaviour and exploration of the unconscious. Secondly, experimental psychology, which was disparaged by most nineteenth-century British psychologists, has established itself. Thirdly, the anecdotal method, once so common in psychology as well as biology, is under sentence of banishment. Fourthly, field-studies have become as important as laboratory investigations. Fifthly, the statistical principles and techniques appropriate to psychological data have received great attention.

In practical usefulness, psychology in Britain has moved during the period under review from a stage where applied psychology was almost unknown to one where psychology is constantly being applied to the practical problems of public and private life. Educational psychology is now an important ingredient in the training of teachers, and educational psychologists are becoming established members of the staffs of education authorities. Psychiatry is a recognized branch of medicine, and clinical psychologists are employed in many fields. Occupational or industrial psychology, the development of which in Great Britain owed so much to Charles Myers, was used on a large scale in the Second World War, and is now being used in the drive for greater productivity.

STUDY OF THE BRITISH FLORA

IN his presidential address to Section K, Prof. J. R. Matthews begins by referring to some of the more noteworthy landmarks in the history of British botany. The exact recording of native plants, an essential preliminary to the formulation of any scientific account of them, dates from the time of William Turner. Although new records have continued to be made down to the present time, the discovery and discrimination of more than a thousand species of vascular plants before the death of John Ray in 1705 remains an outstanding tribute to the work of the early explorers. Much of the subsequent floristic work was carried out by botanists who made no claim to be called professional, and it often found expression in the publication of local or county floras. The value of these surveys could not be seriously doubted, and there is a growing need for their encouragement and support by all responsible authorities, public or private, who have the desire to see a revival of interest in the scientific study of local natural history.

The edifice of British botany raised by the early naturalists gradually became expanded and enlarged, and by the end of the nineteenth century, knowledge of the composition of the native flora was relatively complete. The distribution of plants had also attracted considerable attention, and Great Britain had become one of the best botanically explored countries in the world. But along with other subjects, botany shared in the general scientific renaissance which occurred in the early years of the twentieth century. Although the systematic study and recording of plants continued, greater emphasis began to be laid on the ecological approach to field studies. The investigation of heredity and the study of variation by the experimental method and the advance of cytology were at once recognized as sources of valuable data contributing towards an understanding of the species problem, which had followed the enunciation of the Darwinian theory of evolution. Detailed ecological studies of individual species throughout the range of distribution were necessary, if the responses to changing environmental conditions were to be correctly interpreted. Such investigations were closely connected with problems of taxonomy, since it was evident that much intraspecific variation was related to environmental gradients. It should therefore become the purpose of experimental taxonomy to examine and analyse the heterogeneous nature of the species complex and correlate the results of such analysis with those derived from physiological and ecological studies. Investigations along these lines would prove of immense value in the application of scientific botany to the practice of horticulture, agriculture and forestry.

THE SCHOOL IN A PROGRESSIVE SOCIETY

IN his presidential address to Section L (Education), Mr. W. O. Lester Smith points out that school business has increased rapidly in recent years, affecting each of the leading partners in educational administration—the Ministry of Education, the local authority, the head teacher and his colleagues. It is worth considering how this has come about, and there would seem to be three main causes: social change, the widening scope of education, and the modern emphasis on management. The administrative pressure on the head teacher is more serious in its consequences than that on the other two partners, because hitherto in Great Britain we have regarded the school as the natural growing point of educational thought and technique, and we owe much to the creative wisdom of some of our great head teachers.

It is usual to attribute the increase of administration to the growing demands of Government departments; but this is a partial diagnosis, for the preoccupation of the head teacher with managerial detail began not in the schools associated with the State but in the independent public schools from the days of Thring onwards. It was due largely to the emphasis in these schools on an active corporate life and on giving each pupil a full or 'total' education. In a sense, therefore, the criticized Rugby appointment of an administrator as head master was but a logical recognition of a process that has been unfolding itself for a century.

The head teachers of the primary and secondary schools associated with the State in Britain are now being diverted from their educational task by a growing administrative pressure, and this is particularly unfortunate because the abolition of the elementary school by the Butler Act was a historic opportunity, and the heads of the schools emerging from the elementary tradition ought to be free to concentrate on the difficult task of making education a living force in the social democracy now taking shape. Just when imaginative leadership is urgently necessary, the head teacher's function is becoming increasingly managerial as a result of the growth of corporate activities, the demands of society, and the aftermath of Government schemes and schemes launched by well-meaning importunate organisations.

Some of the new demands are necessary and desirable, but others are hard to justify. There is also an increasing use of schools for extraneous purposes, involving the necessity of putting away daily all equipment and appurtenances of educational or æsthetic value. We cannot hope to achieve quality unless we are prepared to put education first; and it is regrettable that, owing to shortages of staff and buildings, we make a habit of measuring progress in quantitative terms. The schools of the people were for centuries retarded by what Defoe called the law of subordination, and to-day Demos is apt to treat his schools like the old feudalism writ large.

One of the most difficult issues is to determine the extent to which schools should respond to the many claims which society makes upon them. There is general agreement that they cannot to-day thrive in isolation, or, as the McNair Report puts it, teachers cannot be "a race apart". On the other hand, there is a limit to sociability, a plimsoll line at which service to the community becomes a danger to education. If a service rendered by a school fits naturally into the curriculum or the corporate life, it may provide useful educative experience; but if there is a marriage of convenience designed primarily to further an extraneous scheme, there can be serious waste of teacher- and pupil-time without compensating advantage. We ought, as a nation, to recognize before it is too late that the essential function of each school is to educate, and that of each head teacher to give expert guidance to his team in the conduct of an extremely difficult operation, requiring human sympathy and a sure grasp of the intricate problems of childhood and adolescence.

AGRICULTURE AND THE WORLD FOOD PROBLEM

IN his presidential address to Section M (Agriculture), Dr. G. Scott Robertson compares the present world food problem with that in 1798 when Malthus put forward his theory that populations tend to outrun their means of subsistence. The invention of machinery, the discovery of artificial fertilizers, the development of transport and colonization for a time made his views seem unduly pessimistic and out of date, but two world wars have brought up afresh the problem of attempting to provide adequate food for the peoples of the world.

The two chief factors responsible for the present situation are the rapid increase in the world's population (estimated at 20 million per annum) and the improved standard of living of that population. Fortunately, the prospects of finding a solution are more hopeful to-day than they were a hundred and fifty years ago, when hand labour and primitive tools set a limit to agricultural production, for by merely applying existing knowledge and making a fuller use of available resources, the world output could be doubled or trebled in a relatively short time. The Food and Agriculture Organisation is doing valuable work in pointing the way by which this can be done, and the only permanent solution seems to be in increasing production in each country. The requirements of India and China, for example, are so vast that outside help would be inadequate even if it could be provided and the immense transport difficulties overcome.

Aid from the more advanced countries can best be given by helping the less developed ones to modernize their agriculture so that they can feed their own peoples. To do this, very large quantities of fertilizers will be required, and fertilizer manufacture must form a part of their industrialization. Even in Europe and America, much could be done to improve output. More attention to the growing and conservation of grass, for example, would increase milk and meat production and at the same time reduce the competition with the human population for cereals. Enormous economies in grain crops could also be achieved if the ravages of pests during storage were prevented; the knowledge exists and only the practical application of it is needed. The Council of the Food and Agriculture Organisation has already taken this matter up and recommended member countries to take immediate and concerted action in such matters.

Losses in the animal world from disease are estimated as even more serious than in the case of crops, and the necessity for preventing this wastage becomes the more vital as the standard of living rises not only in advanced countries but also in the more primitive.

Improved nutritional standards will inevitably mean changes, for agricultural produce will have to play a more important part in world trade than in the past, and the old conception of exchanging agricultural for industrial products gradually give place to an interchange of agricultural products. Restrictions, such as tariffs and quotas, will have to disappear, for no country should be forced into a form of agriculture unsuited to its soil and climatic conditions. The peoples of the world, in fact, will not be properly fed or any real prosperity achieved until there is both a greatly increased output and the fullest interchange of the products of agriculture on a world-wide scale.

THE CORRESPONDING SOCIETIES AND THE COMMUNITY

THE president of the Conference of Delegates of Corresponding Societies, Prof. H. J. Fleure, deals in his address with the relationship between the corresponding societies and the community. Many such societies belong to and have opportunities to serve our cities and counties in the important and necessary effort to re-emphasize social life, which has been submerged by the crowds that have taken the place of traditional groups, crowds made up of atomized individuals. Rousseau, Hobbes and others have too often spoken as though human society were made by the coming-together of individuals, whereas it is in society, itself basically a heritage from pre-human phases, that human individuality has struggled towards expression. The group again and again has sought order through imposed uniformity; the individual has, increasingly, rebelled and has immensely extended men's vision. We need only read anything written about man and the universe before Copernicus, Bruno, Galileo, Newton and Darwin to realize the importance of the newer ideal "We seek the truth"; imposed uniformity may prevail for a short time, but it must fade; it closes the mind.

In the late eighteenth century steam-power and mass-production set society sailing on an uncharted sea and found it philosophers to justify or excuse exploitation under the theory of *laisser-faire*. The atomization of the individual, the submergence of society in the crowd, have been widespread with unfortunate consequences. The corresponding societies and the British Association, both pledged to the search for truth, can help one another and our communities towards rehabilitation. The local society can help and advise planners in their work of adjusting the environment and can bring wisdom from the past without, one hopes, imposing that as a dead weight on the future.

The Education Act, 1944, assigns 'secondary' status to many schools hitherto primary, and in these the education, for the less bookish, must be to a considerable extent visual. Members of local societies can help in the schools to spread knowledge of the locality, can guide school parties, promote local museums of folklife, publish books and booklets that will help teachers and pupils to understand their locality; and the British Association can help with advice on such work; it could also organise short conferences in many towns and cities which cannot quite manage the full annual conference, sending delegates specially chosen because of the help they can give. Contacts spread over a few days and extending into the field as well as the lecture room can be more vitalizing and have a more enduring effect than visits of a lecturer for one evening's meeting.

Co-operative research on land utilization, on interpretation of Domesday and other historical surveys, on local names and implements, land tenures and field systems can all be made to help rehabilitate social life. Much of this work can find expression not only in the transactions of local societies, but also in local museums made intelligible to the public, in improved education with partnership between the societies and the teachers and pupils, as well as in scientific contributions to a National Atlas of Britain, a new survey of land utilization and many other efforts of both planners and historical and scientific searchers.

NEWS and VIEWS

Death of President Beneš

By the passing of Dr. Eduard Beneš on September 3 at the age of sixty-four, Czechoslovakia loses its former president, and the world loses a cultured and learned man who had striven for the welfare of all mankind during the past forty years. Born in the Bohemian village of Kožlany on May 28, 1884, Beneš studied philosophy, philology and sociology at Prague and later at Dijon, where his thesis was "Le problème autrichien et la question tchèque". Beneš then spent a short time in London and Berlin before returning to Prague, where he attracted T. G. Masaryk's attention. In 1915 Beneš escaped to Geneva, and with Masaryk and Štefánik (a Slovak astronomer who became an air force general and Czechoslovak War Minister) organised Czech resistance to the Central Powers. Beneš became Czechoslovak Foreign Minister of the first provisional Government, and after the republic was established in October 1918, he retained that post in successive administrations until he succeeded Masaryk as president in 1935. His work became more arduous with the rise of Nazism in Germany, and Beneš had soon to face another exile. Returning in 1945 as president of liberated Czechoslovakia, he was confronted with greater problems than before, since war and occupation had brought more distress than the First World War. The strain of post-war anxieties, the events of February last and Jan Masaryk's suicide, deeply affected him. President Beneš, who had always maintained an interest in learning and culture (especially in the social sciences) made his last public speech on April 7, at the sexcentenary celebrations of the University of Prague (see *Nature*, May 1, p. 670). Among the exhibits in connexion with these celebrations were several items associated with Benes' academic life, including the original Dijon thesis. Since February, President and Mme. Beneš had lived in their country house at Ústí Sezimovo in south Bohemia and had taken no part in public affairs, although he did not resign from the presidency until June 7. Like the Masaryks, Beneš was a 'great European' with wide vision, and though his work for greater understanding among peoples seems recently to have been in vain, he has shown mankind the way.

Presentation to Sir John Parsons, C.B.E., F.R.S.

At a ceremony held in the Royal College of Surgeons on September 3, Sir John Parsons was presented with his portrait in oils, painted by Mr. John Gilroy. The presentation was made by Sir Stewart Duke-Elder, in the name of the members of the Faculty of Ophthalmologists and the Ophthalmological Society, and to mark the celebration of Sir John's eightieth birthday. It is good that Sir John's long and strenuous career has met with such a fitting and happy culmination, for he has long been the acknowledged leader in all aspects of British ophthalmology —clinical work, basic research and public activities. For more than a generation he has been the recognized leader in the clinical practice of this specialty, and opthalmologists of a much wider circle than Great Britain to-day treat their patients better because of his precepts and his writings. So long as ophthalmology is a science, his name will be remembered for the work he did fifty years ago as a pioneer in ophthalmic pathology. To-day he is still the foremost authority in the fundamental sciences concerning vision—biological, physiological and psychological. In guiding, stimulating and encouraging ophthalmic research he has in his time stood out almost alone. In all problems concerning vision successive Governments and industry have asked and received his help; he served in the two World Wars, in the First as consultant to the Army, in the Second as adviser to the Royal Air Force; in international ophthalmology he has consistently been an acceptable and gracious British ambassador; and for years he was the dominant figure in the social and political life of the ophthalmologists of Britain.

Probably, however, the greatest contribution which Sir John Parsons has made is the historical continuity he has succeeded in maintaining between the past and the future. In his youth, ophthalmology in Britain was great among the nations; but later—largely because with the evolution of science, individual effort had to give place to organised effort for which we were not prepared or equipped—ophthalmology undoubtedly lost its place in Britain. He was largely responsible for reinvigorating it to what may be a future as great as or greater than its past. To-day those who have eyes to see may discern the beginnings of the fruits of his labours. Thirty years ago he was responsible for interesting the Medical Research Council in ophthalmological problems, and to-day these are fully consolidated. Twenty years ago he endeavoured to bring about an amalgamation of London hospitals and inaugurate a research institute; to-day, that is an accomplished fact. He was primarily responsible for the inauguration of the Faculty of Ophthalmologists, and to-day it is growing lustily. To him and to all of us these promising developments of his ambitions ought to be a source of satisfaction.

Physiology at the London Hospital

Prof. D. T. Harris

Prof. D. T. Harris, on whom the title of professor emeritus has been conferred by the University of London, is to retire at the end of the present session from the chair of physiology which he has held at the London Hospital for the past sixteen years. Prof. Harris studied physics as a special subject at Cardiff, where he took his B.Sc. in 1904. He graduated in medicine at Manchester in 1914 and after holding various hospital appointments and experiencing general practice served as a temporary captain in the R.A.M.C. After a short period as lecturer in physiology at Manchester under Prof. William Stirling, he joined the Institute of Physiology at University College, London, where he held a Beit Memorial Research Fellowship and as Sharpey Research Scholar came under the influence of Sir William Baylis and Prof. E. H. Starling. He obtained the D.Sc. London in 1926 and held the post of assistant professor of physiology in University College, London, when he was appointed to the chair at the London Hospital in 1932. Throughout his academic career Prof. Harris has maintained his interest in physics, his scientific work being mainly concerned with problems arising in the territory bridging physics and physiology, and in particular with the biological action of ultra-violet radiations and ultra-short waves. His contributions to knowledge of these subjects have been published in a series of papers in the *Journals of Physiology*, *Biochemistry* and *Scientific Instruments*, and his textbook on "Ultra-Violet Radiation" is widely used by

operators of ultra-violet lamps who wish to study underlying principles and methods of measurement. In another direction he applied his knowledge of physics to his hobby—photography—and this brought him in contact with the scientific research workers in the cinematograph industry, to whom he gave a series of lectures on stereoscopy.

In the immediate post-war period of intensified university education of 1919–22, Prof. Harris found full scope for his exceptional and natural aptitude for teaching. Large numbers of medical students, and in particular the ex-Service group who came back to complete their medical studies under a sense of urgency to make up for lost time, have cause to be grateful to him for the personal interest he took in their problems and for the systematic clarity of exposition which characterized his lectures and the practical courses he gave for the examinations of the University of London and the Royal Colleges. His book on experimental physiology is used by students in many parts of the world. As a teacher and examiner, Prof. Harris has played a notable part in medical education during the past thirty years, and his many friends will be gratified to learn that, even after his retirement from the London Hospital, he will actively participate in the developments in the teaching of physiology sponsored by the Royal College of Surgeons.

Agricultural Research Council: Lord Rothschild

THE Committee of the Privy Council for Agricultural Research has appointed Lord Rothschild to be chairman of the Agricultural Research Council in succession to Lord De La Warr. Lord Rothschild was born in 1910 and was educated at Harrow and Trinity College, Cambridge, of which he was a fellow during 1935–39. He served in the Army Intelligence Corps during the War and was awarded the George Medal in 1944; was mentioned in dispatches and received the American Bronze Star and Legion of Merit. Lord Rothschild is a biologist, who has carried out research work in the Department of Zoology at Cambridge and has published a number of scientific papers; he has also agricultural interests. He is a member of the boards of the British Overseas Airways Corporation and the Overseas Food Corporation.

Central African Scientific Liaison Office: Mr. R. McChlery

ON September 1, the Central African Council established, on behalf of the Governments of Southern Rhodesia, Northern Rhodesia and Nyasaland, a Central African Scientific Liaison Office in the British Commonwealth of Nations Scientific Offices, Kingsway, London. This arrangement whereby three Colonies, acting jointly, follow the lead of the Dominions by appointing a scientific liaison officer to London provides an interesting new phase in the developing pattern of Commonwealth scientific relations. Mr. R. McChlery, who becomes the first Central African scientific liaison officer in London, went from school at Salisbury, Southern Rhodesia, to take a science degree at Rhodes University College, Grahamstown. He was then awarded a Rhodes Scholarship and proceeded to Exeter College, Oxford, where he obtained the B.A. degree in chemistry in 1925 and the B.Sc. degree in 1926. Following a short course of study at Rothamsted Agricultural Research Station he returned to Southern Rhodesia to join the Chemistry Branch of the Department of Agriculture, where he has since been employed, mainly on problems connected with soil fertility and crop production.

Oxford Science

Oxford Science makes a welcome reappearance after an absence of nearly nine years. Under the general editorship of F. A. Holland, it gives a survey of scientific development in the University of Oxford and is particularly designed to keep the person with a scientific education informed of the progress made in fields of science other than his own. Articles in the present issue (**2**, No. 1, June 1948) are by A. J. Birch and D. K. C. MacDonald on metal-ammonia solutions; C. J. Dickenson on functional organisation within the cell; J. D. Dunitz and S. C. Wallwork on some developments in structural chemistry; A. H. Cooke on magnetism at low temperatures, and H. M. Sinclair on nutritional science. In the editorial, reference is made to the part played by Oxford men of science in the nation's war effort, to the new laboratories under construction or about to be constructed, and to the closing down of the last of the college laboratories, so that laboratory teaching is now entirely in the hands of the University staffs. Only brief mention is made of the important physical work done in the new Clarendon Laboratory; but a fuller report can be found in *Oxford*, **9**, No. 2, p. 54 (1946–47). Those interested in the progress of chemistry at Oxford may like to refer to the article by F. M. Brewer in *Oxford*, **9**, No. 3, p. 98 (1948), which is very informative.

United States Book Exchange

A BUREAU for the international exchange of books and periodicals between libraries, scientific and educational institutions of the United States and other countries has been opened in the Library of Congress, Washington, D.C. The organisation, known as the United States Book Exchange, is a successor to the American Book Centre for War Devastated Libraries, Inc., and the executive director is Miss Alice D. Ball, formerly acting director of the Book Centre. While the new organisation will continue the rehabilitation programme of the Book Centre, libraries of foreign countries are expected to become members of the new Book Exchange and contribute material to the programme as well as draw from it. During the past two and a half years, more than 1,250,000 volumes have been sent out by the Book Centre, to war-devastated libraries in thirty-one countries. At first the activities of the Book Exchange are being limited to printed matter of scientific or literary character; this will include books, pamphlets, periodicals, government documents, music, printed leaflets, and occasional papers. At present no microfilm and microprint will be dealt with, and no motion pictures, art reproductions and newspapers; but it is hoped eventually to handle all types of printed and filmed material.

Mitigation of Spray Injury

IT is an essential prerequisite of a fungicidal spray that it should not itself cause damage on the plants to which it is applied. This is, unfortunately, not always the case, for lime-sulphur sometimes causes early leaf-drop on the apples Cox's Orange Pippin and Worcester Pearmain. M. H. Moore has shown (*J. Pom. and Hort. Sci.*, **23**, 3 and 4, Dec. 1947) that

this damage can be greatly reduced by adding 4 lb. of ferrous sulphate crystals to every gallon of lime-sulphur concentrate before dilution. Sprays against apple scab were made according to the usual schedule. The relative effects of calcium arsenate and lead arsenate separately mixed with lime sulphur as post-blossom sprays were also estimated. Calcium arsenate powder proved more toxic to the apple leaves than lead arsenate paste of much less arsenic oxide equivalent. The inclusion of ferrous sulphate in the mixtures, however, reduced the leaf-drop; but did not markedly prevent fruit-drop. Zinc sulphate provided no suitable alternative to ferrous sulphate; it was highly phytotoxic.

Parallelism between Atomic and Planetary Properties

A SHORT article with the above title in *Nature* of May 15, p. 780, directed attention to the formulation by M. F. Prunier of a wave equation for astronomical planetary systems similar to Schrödinger's equation for atomic systems. It has just been brought to our notice that a somewhat similar hypothesis had been put forward earlier by Mr. B. Liebowitz, of New York (*Phys. Rev.*, **66**, 343; 1944). His equation is satisfied by a variable which he calls the "probability of presence". The subsequent development, very surprisingly, seems to show that for a purely classical problem concerning the planets, akin to Bode's law, using purely classical arguments, an equation can be obtained which has the same form and meaning as Schrödinger's essential non-classical equation. But, in sharp opposition to the conclusion of M. Prunier, Mr. Liebowitz says that there is no implication of a magnetic moment associated with the angular momentum. It will be recalled that the possibility of such a relation, particularly for the earth's magnetism, has been much discussed since Prof. Blackett's article in *Nature* (**159**, 658; 1947) was published.

The Coco-nut Research Scheme

THE annual report for 1944 of the Coco-nut Research Scheme (Government Record Office, Colombo, Ceylon, 40 cents, 20 pp., Jan., 1948) shows that in addition to many routine analyses of copra and coco-nut products, a more detailed examination of the dry distillation of coco-nut shells has been made. The yield of pyroligneous acid was 38·2 per cent and of settled tar, 5·6 per cent. Total acid (as acetic) accounted for 11·6 per cent of the pyroligneous acid, which also contained about 3 per cent of wood spirit. An attempt to use coco-nut shells as a starting material for the preparation of furfurol gave rather poor yields. Manurial experiments with nitrogen, phosphorus and potash indicate that only the potash increased the yield of copra, beginning at the fourth year from commencement of applications. On poor soils, complete manuring with all three major nutrients gave a marked increase in the number of female flowers. Various other experiments on cultivation are also described in the report.

The Royal Anthropological Institute

THE report of the Council of the Royal Anthropological Institute for July, 1947–June, 1948 has appeared. It is pleasing to gather that real progress has been made in all directions. The Institute has always been handicapped through lack of means and in other ways. Though these disabilities have by no means all been overcome, improvement can be clearly noted. The membership is rising, and the library is now in better order. Much activity has been shown in many directions. The Institute fulfils an important function in a country like Great Britain which lies at the centre of a great Empire, and every effort should be made to help it to do what it alone can accomplish for the study and understanding of the many primitive peoples it is still our lot to sustain.

Erdoel und Kohle

THE former German oil journal, *Oel und Kohle*, has now appeared under the title *Erdoel und Kohle* (von Hernhaussen, Hamburg; annual subscription, 60 marks). The first issue of 56 pages was brought out by Dr. Karl Zerbe in June. Its contents cover the future problems of petroleum geology and geophysics and the possibilities of applying secondary recovery methods. In the refining section there are articles on the progress of hydrocarbon synthesis and dewaxing. Scientific abstracts and short commercial notices are included. This journal is the official organ of several technical associations.

Seventh Pacific Science Congress

THE Seventh Pacific Science Congress will be held in Auckland and Christchurch, New Zealand, under the auspices of the Royal Society of New Zealand, and with the assistance of the Government of New Zealand, during February 2–22, 1949. As in previous Congresses, members will be classified as official members (delegates representing the constituent countries of the Pacific Science Association and specially invited guests), members (accredited by scientific bodies) and participants. The Congress will be organised in ten divisions, and within divisions there will be a varying number of sections. The programme is arranged in the form of symposia for the discussion of topics of wider interest for the Pacific peoples; within divisions, subjects of specialist or technical interest will be presented at section meetings. Among the subjects for symposia are: structure of the Pacific basin; Antarctic and Pacific meteorology; oceanography and fisheries of the Pacific; biogeographical provinces; soil resources; ethnographic studies in Micronesia; medical and nutritional problems of the Pacific area. The president of the Congress is Mr. R. A. Falla, president of the Royal Society of New Zealand and director of the Dominion Museum, Wellington; the secretary-general is Mr. Gilbert Archey, director of the Auckland Institute and Museum, Auckland, S.E.1, to whom all communications should be addressed.

Announcements

THE Queen has been graciously pleased to accord her patronage to the Royal Society of Edinburgh, of which H.M. the King is patron.

AT the National Gallery, London, Mr. Martin Davies, who is chiefly in charge of the library, and Mr. Ian Rawlins, scientific adviser, have been appointed deputy keepers.

MR. J. V. CONNOLLY, who has served since 1937 at the Air Ministry, Ministry of Aircraft Production and Ministry of Supply, recently as assistant director of aircraft production, has been appointed professor of aircraft economics and production at the College of Aeronautics.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Creep of Metals and Recrystallization

THERE has been a certain amount of dispute as to the fundamental laws of creep of polycrystalline metals[1]. I have advanced the view that the normal creep of a rod extending longitudinally under constant stress can always be represented fairly closely by the formula

$$l = l_0(1 + \beta t^{1/3})e^{kt},$$

where l is the length at time t, l_0 is approximately the initial length and β and k are constants. This gives a final rate of extension per unit length which tends to become approximately constant. On the other hand, it has been contended that there is a final state of accelerated creep, called[2] by some metallurgists Stage 4. When the total extension is of some per cent, this stage is often obtained in tests at constant load and can then, on my view, be attributed to increasing stress, consequent upon the thinning of the specimen. As argument against this, it has been pointed out that the increasing rate of creep has been obtained with extensions of less than 1 per cent in the case of certain steels at high temperature (see Fig. 1)[3]. This I have, however, attributed to recrystallization during the process of creep, recrystallization having been shown to produce increased rate of flow in certain cases[4].

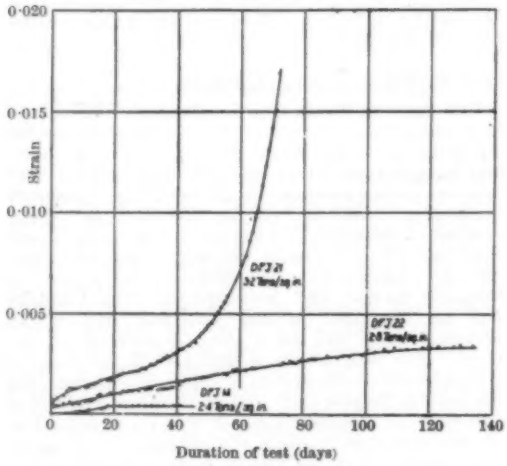


Fig. 1. Creep of a high-nickel–high-chromium steel at 800° C.

Certain experiments which Miss Charmian Sinclair has been carrying out with me on the flow of metals under constant stress throw light on this point. The metal in question is a pure lead (Tadanac virgin lead, of purity approximately 99·99 per cent) which was prepared by extrusion at 100° C. and kindly supplied to me by Mr. G. L. Bailey, director of the British Non-Ferrous Metals Research Association. It turns out that this metal, although normally stable at atmospheric temperature, recrystallizes under stress, the crystals increasing in size from about 0·05 mm. up to about 0·3 mm. linear dimensions.

Fig. 2 shows length against time for a range of stresses, each stress being maintained constant during flow by an Andrade–Chalmers constant stress bar[5]. It will be seen that the form differs markedly from that obtained with normal metals, which is represented by the broken line, obtained with normal lead extended at about the same temperature at constant stress. For the recrystallizing lead there is a stage of accelerated creep during the first ten minutes which is followed by a final creep at an approximately constant rate. The form of creep curve during the first ten minutes resembles closely that for the steels at high temperature. Whether the steels would, at like extension, ultimately creep at constant rate, cannot be said, but the 2·8 tons/sq. in. curve suggests that it may be possible.

It is clear, in any case, that recrystallization during creep has a fundamental effect on the form of creep curves. So far we have examined the wires microscopically only before and after creep, and noted the very marked recrystallization that has taken place. We are about to examine the state of crystallization at different stages of creep, with the object of connecting the rate of creep with the process of recrystallization.

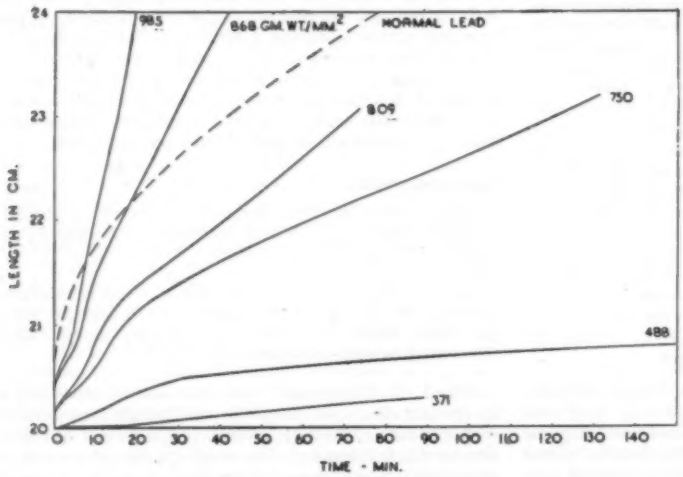


Fig. 2. Creep of a very pure lead which recrystallizes under stress

E. N. DA C. ANDRADE

University College,
London, W.C.1.
June 29.

[1] For example, *Nature*, **157**, 469 (1946).
[2] Hanson, D., Amer. Inst. Mining and Met. Eng. Tech. Pub. No. 1071.
[3] Tapsell, H. J., and Remfry, J., D.S.I.R. Engineering Research Special Report No. 15 (1929).
[4] For example, Bristol Conference Report, Physical Society (in the press).
[5] Andrade, E. N. da C., and Chalmers, B., *Proc. Roy. Soc.*, A, **138**, 348 (1932).

Creep of Metals Subjected to Compression Stress

THE progress of creep in metals in the case of applied tensile stress is usually divided into three stages: (1) an initial decelerating rate of creep (primary creep); (2) a stage of approximately constant creep-rate (secondary or steady state creep); (3) a final accelerating state of creep, leading to fracture (tertiary creep often ascribed in materials undergoing large deformations to increase in stress due to decreasing cross-sectional area as creep proceeds).

We have conducted creep tests in compression at a constant load on some typical creep-resistant nickel–chromium alloys, which in tensile creep tests at the same initial stress and temperature show the three stages of creep referred to above. During the course of these tests, we have made the following observations:

(*a*) The creep-rate in the secondary or constant state stage of creep is approximately the same in tensile and in compressive tests.

(*b*) Tertiary creep occurs in compression as well as in tension, and its onset in compressive tests occurs at approximately the same time as in tensile tests.

(*c*) Whereas in tensile tests, creep in the tertiary stage proceeds at an accelerating rate until fracture ensues, in corresponding compressive tests creep proceeds in a series of accelerating and decelerating rates.

Fig. 1 illustrates a typical compressive creep test showing primary and secondary creep, the onset of tertiary creep, and a stage of decelerating and accelerating creep in the tertiary stage. Fig. 2 is a comparison of the tensile and compressive creep of samples of identical alloy under the same conditions of stress and temperature. The accelerating rate of tertiary creep in the tensile specimen and the stages of acceleration and deceleration in the tertiary creep stage of the compressive creep specimen should be noted.

We believe that this is the first observation of tertiary creep in compression tests. The fact that it occurs after the same time has elapsed in both tension and compression tests suggests that its onset in

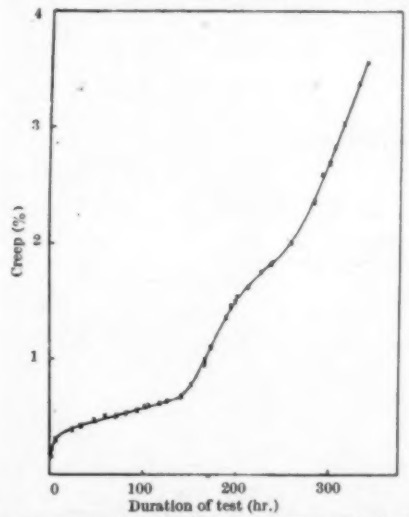


Fig. 1. Creep test in compression on a complex nickel–chromium alloy under a stress of 3·5 tons/sq. in. at a temperature of 900° C.

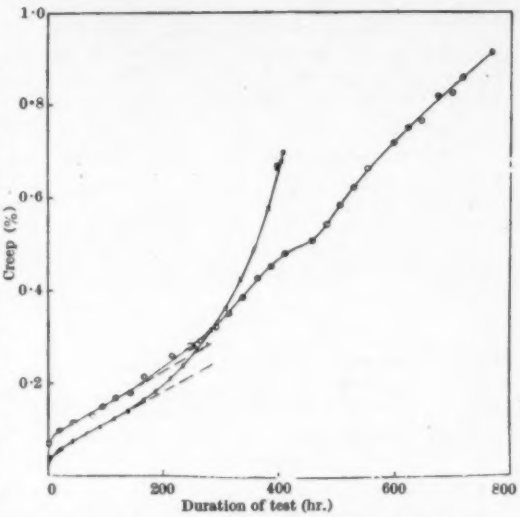


Fig. 2. Comparison of tensile and compressive creep under a stress of 9 tons/sq. in. at a temperature of 815° C. x, tension creep test; o, compression creep test

tension tests in these materials is in no way connected with the increase in stress resulting from a reduction in effective cross-sectional area due to creep. Increase in stress due to decrease in cross-sectional area is, of course, a factor accelerating creep in materials such as pure metals tested at stresses that cause relatively large deformations to occur during the creep test.

It is suggested that a study of the differences between tensile and compressive creep in the tertiary stage may enable certain deductions to be made about the mechanism by which this stage of creep occurs. We tentatively suggest that, in both tension and in compression, tertiary creep is initiated by atomic rearrangement in the most heavily strained zones adjacent to the crystal boundaries, the onset of which may be determined by the amount of strain which the specimen has undergone. This rearrangement may represent the initial stages of a recrystallization process similar to that which has been stated by Greenwood and Worner[1] to be responsible for successive stages of accelerating and decelerating creep in tensile creep tests on lead and lead alloys. If this acceleration of creep-rate occurs by slip processes in the zones adjacent to the boundaries, it will lead to misfit at grain boundaries and, in the case of applied tension, to the formation of fissures at the grain boundaries at large angles to the applied stress, causing a further acceleration of creep-rate and rapid fracture. The formation in tension of such fissures at or near the grain boundaries and an accompanying decrease in density have been demonstrated by Hanson and Wheeler[2].

In compressive creep, we suggest that such fissures in boundaries making large angles to the direction of the applied stress cannot form as readily as in the case of tensile creep, so that creep may proceed by a series of hardening processes, due perhaps to the blocking of dislocations, and to recovery processes akin to the onset of recrystallization. These hardening and recovery processes may be localized in material adjacent to the grain boundaries, due to the stress concentrations in these regions brought about by flow in the boundaries.

We intend to make further correlation of compressive and tensile creep in materials free from the metallurgical complexities of commercial creep-resistant alloys, in order to obtain further data.

We are indebted to the Ministry of Supply, under the sponsorship of which the work was conducted, for permission to publish these results, and to Mr. W. H. Mayes, who was responsible for the construction of the apparatus, which was similar in principle to a machine in use at the National Physical Laboratory.

A. H. Sully
G. N. Cale
G. Willoughby

Fulmer Research Institute, Ltd.,
Stoke Poges, Buckinghamshire.
July 6.

[1] Greenwood, J. N., and Worner, H. K., *J. Inst. Metals*, **64**, 135 (1939).
[2] Hanson, D., and Wheeler, M. A., *J. Inst. Metals*, **45**, 229 (1931).

Isotopic Assignment of the α-Activity of Samarium

The recent report by Dempster[1] that the earlier conclusion of Wilkins and Dempster[2] regarding the α-active isotope of samarium is unreliable makes necessary the revision of a great deal of past speculation. Previously the α-activity was assigned to ^{148}Sm; now it appears that ^{152}Sm is almost certainly the isotope responsible.

It is the object of this note to point out that (once the shock of this radical re-assignment is forgotten) the new result is more easily reconcilable with other evidence than is the old. Earlier arguments attempting to explain why the range of elements neodymium (60) to samarium (62) is particularly liable to α-disintegration, and seeking to compare this range of elements with that neighbouring upon polonium (84), the most α-unstable of the classical radioelements, are not affected; but the details of the picture are filled in with much greater consistency than before.

The outside evidence of most direct relevance is that regarding isotopic hyperfine structure in the spectra of neodymium and samarium. With samarium, Schüler and Schmidt[3] found an anomaly in the relative separations of the isotopic hyperfine structure components; later a closely similar anomaly was found by Klinkenberg[4] with neodymium. For all other even-numbered elements so far examined the isotopic hyperfine structure consists of components which to a good approximation are linearly spaced in respect of mass number on a frequency scale (at least so far as the components of even mass number are concerned). With samarium this linear spacing is interrupted by an abnormally large interval between the components of mass numbers 150 and 152, and with neodymium there is similarly an unusually large interval between components of mass 148 and 150. Basically these anomalies are interpreted as evidence for an abnormal increase of nuclear radius (more exactly of the proton-occupied volume of the nucleus) between ^{150}Sm and ^{152}Sm, as also between ^{148}Nd and ^{150}Nd; scarcely less directly they may be regarded as evidence for a 'discontinuous' decrease in nuclear binding energy as between these pairs of even isotopes. Classifying on this basis the samarium isotopes of mass numbers 144, 148, 150 and the neodymium isotopes 142, 144, 146 and 148 as 'tightly bound' and the samarium isotopes 152, 154 and the neodymium isotope 150 as 'loosely bound', it is clear that the only possibility for α-disintegration from a loosely bound samarium to a tightly bound neodymium is, in fact, the possibility $^{152}\mathrm{Sm} \xrightarrow{\alpha} {}^{148}\mathrm{Nd}$. There is every reason to expect, therefore, that ^{152}Sm is the predominantly α-active samarium isotope. A tentative suggestion to this effect was, in fact, made by Schüler and Schmidt[3] in 1934.

Returning to the comparison of the α-activity of samarium with that of the classical radioelements—and with the α-activities of the polonium isotopes in particular—we may note how recent results serve to correct previous misconceptions. Previously it has been too readily assumed that α-activity becomes more pronounced as the mass number (A) decreases; for polonium (84), at least, the work of Howland, Templeton and Perlman[5] shows that this is not the case. The annexed table gives the total energy of

A	206	207	208	209	210	211	212	213	214	215	216	217	218
E (MeV.)	5·3	5·2	5·24	?	5·40	7·58	8·95	8·45	7·83	7·51	6·90	(6·45)	6·11

α-disintegration (E) of the isotopes from $A = 206$ to $A = 218$. The pattern of variation is obvious from the figures quoted. The 'pure α-active' species for this element ($Z = 84$) are the isotopes of mass numbers 208, 210, 211, 212, 213 (?), 214 and 216; these are the species which correspond to the stable isotopes of the elements[6] of atomic number $Z \leqslant 83$. It is clear that the maximum α-disintegration energy in this case ($Z = 84$) belongs to the even-numbered isotope, which occupies the mid-place in the sequence of β-stable species $A = 208, 210, 212, 214, 216$. The case of samarium is seen in comparison to be not so different as might previously have been supposed.

N. Feather

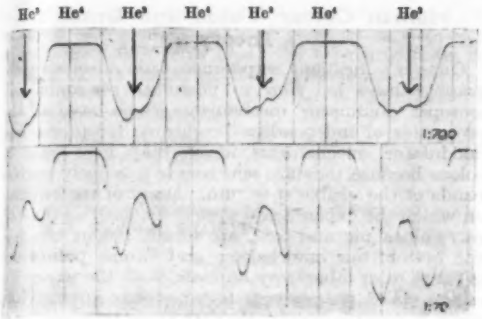
Department of Natural Philosophy,
University of Edinburgh.
July 26.

[1] *Phys. Rev.*, **73**, 1125 (1948).
[2] *Phys. Rev.*, **54**, 315 (1938).
[3] *Z. Phys.*, **92**, 148 (1934).
[4] *Physica*, **11**, 327 (1945).
[5] *Phys. Rev.*, **71**, 552 (1947).
[6] Turner, *Phys. Rev.*, **57**, 950 (1940); *Rev. Mod. Phys.*, **17**, 292 (1945); Feather, *Rep. Prog. Phys.*, **11** (1948).

Spectrum of Helium-3

The possibility of obtaining samples of helium in which the isotope of mass 3 has been enriched allows the isotope shifts in the arc spectrum of this element to be investigated. The first samples, which had kindly been made available to us by Dr. Rollin and Mr. Hatton[1], had been prepared by means of thermal diffusion, and contained helium-3 in a concentration of 1 : 700. With an ordinary Fabry Pérot étalon, the detection of satellites several hundred times weaker than the main line is impossible, owing to the finite background intensity of this instrument. This difficulty was overcome by the use of two étalons, of equal spacings, in series. By suitable choice of apertures, distances and orientations of the wedge-shaped étalon plates, it was found comparatively easy to avoid secondary reflexions. The method appears to be very useful for the investigation of faint satellites very close to strong lines.

The upper part of the figure shows a photometer tracing of the line 2^1S–3^1P, 5015 A., photographed with two étalons in series, each of spacing 0·318 cm. The peaks due to helium-3 are small, but clearly visible between the large peaks of helium-4, which appear flattened at the top as the result of over-exposure. A sample in which the helium-3 had been



further enriched to a concentration of 1 : 70 by the method of evaporation at very low temperature[1] became available later, and its spectrum is shown in the lower part of the figure. Comparison of the two tracings demonstrates the enrichment achieved by this method. Rough photometric estimates of the intensities agree with the concentration of the samples measured in the mass spectroscope.

The background which appears in the tracings is largely due to the finite width of the helium lines, not to instrumental effects. The intensity ratio 1 : 700 does not, therefore, represent the limit of sensitivity of the method.

In the highly enriched sample, the satellite could also be photographed and measured with a single étalon. The helium-3 line was found to have a separation of $-0{\cdot}83 \pm 0{\cdot}03$ cm.$^{-1}$ from the helium-4 line.

A theory of isotope shifts in two-electron spectra due to mass effects has been developed by Hughes and Eckart[2,3]. It is based on the assumption of hydrogen-like wave functions with effective nuclear charges. On the basis of their calculations for the $2P$ states, the value of the effective charge Z_s for the $1s$ electron in the $3P$ states can be assumed to be 2·00, giving a value of $Z_p = 0{\cdot}996$ for the $3p$ electron in the 3^1P state. This gives an isotope shift of the line 2^1S–3^1P of $-0{\cdot}77$ cm.$^{-1}$, which is outside the limits of error of the experimental value. The difference may be due to the approximations contained in the theory, or to the influence of factors other than the pure mass effect.

Details of the spectroscopic method will be published elsewhere.

L. C. Bradley*
H. Kuhn

Clarendon Laboratory,
Oxford. July 22.

* Rhodes scholar.

[1] Rollin, B. V., and Hatton, J., *Phys. Rev.* (In the press).
[2] Hughes, D., and Eckart, C., *Phys. Rev.*, **36**, 694 (1930).
[3] Eckart, C., *Phys. Rev.*, **36**, 878 (1930).

Vibrating Electrodes in Polarography

The constant diffusion conditions necessary for polarographic work have hitherto been attained by use of the dropping-mercury electrode, the streaming mercury electrode[1], the rotating platinum micro-electrode[2], or even by a fixed micro-electrode and a constant electrolyte streaming-rate[3].

We have found that a platinum micro-electrode vibrating at a constant frequency (100 cycles per second) with an amplitude considerably greater than its linear dimensions gives constant diffusion conditions, and with such an electrode we have obtained reproducible polarograms. The electrode is free from irregularities due to external vibration and gives smoother curves than those obtained with the dropping-mercury cathode.

E. D. Harris
A. J. Lindsey

Sir John Cass Technical Institute,
Jewry Street, London, E.C.3.

[1] Heyrovsky, J., *Chem. Listy*, **40**, 222 (1946).
[2] Laitinen, H. A., and Kolthoff, I. M., *J. Phys. Chem.*, **45**, 1079 (1941).
[3] Muller, O. H., *J. Amer. Chem. Soc.*, **69**, 2992 (1947).

Evidence of Geological Age against Decay of Tin-115 to Indium-115 by Electron Capture

According to a rule of nuclear stability, it is improbable that two neighbouring elements (neighbouring Z) have stable isotopes of the same nominal mass, that is, stable neighbouring isobaric pairs should not exist. A few apparent exceptions to this rule are known, one of which is the pair, $_{49}In^{115}$ and $_{50}Sn^{115}$.

In indium, the relative abundance of In^{115} is 95·5 per cent, and in tin, the relative abundance of Sn^{115} is 0·4 per cent: In^{115} is thus an abundant indium isotope, whereas Sn^{115} is a minor tin isotope; this has caused some nuclear physicists, for example, Fluegge[1], to suggest that Sn^{115} has probably decayed by orbital electron capture to In^{115} during the life-period of the earth.

Recently Kohman[2] has discussed β-stability of all nuclei, and by means of his β-stability diagram has been able to predict that for the pair, Sn^{115} and In^{115}, Sn^{115} should be unstable, which accords with the above suggestion by Fluegge[1]. Kohman[2] refers to an earlier paper by Eastman[3], which, on the basis of atomic mass calculations, would also favour decay of Sn^{115} to In^{115}. A later paper by Eastman[4] invokes geochemical evidence, namely, the association of traces of indium with tin in tin minerals, as indicative of electron capture decay to indium-115. Since this publication appeared, many more tin minerals have been analysed, notably cassiterite; in some, traces of indium have been found, whereas in others no indium could be detected. Of considerable interest is a paper by Itsikson and Rusanov[5] which reports analyses of many specimens of cassiterite from the U.S.S.R.: the useful conclusion is made that although specimens of cassiterite associated with sulphide veins usually contain traces of indium, specimens from pegmatite are likely to be free from detectable quantities.

Direct observations on the production of characteristic X-radiation which would result from electron capture decay by tin-115 have been made by Zingg[6]. His results are inconclusive, as, in three specimens of tin he examined, very feeble activity could be detected, whereas in a fourth specimen no activity was observed. Later, similar observations by Rusinov and Igelnitzky[7] failed to reveal the presence of any X-radiation, and these authors set the minimum value for the period of half-life (T) for Sn^{115} as greater than $1{\cdot}0 \times 10^{15}$ years.

As a result of the considerable diversity of opinion and experimental evidence mentioned above, I have attempted to utilize geochemical evidence of the type referred to before, for establishing whether significant decay of tin-115 by electron capture decay has taken place or not. For this purpose, three requirements have to be fulfilled: the absolute age of the mineral has to be known; this age must be extremely great—

if possible, of the same magnitude as the age of the earth—and, finally, contamination by non-radiogenic indium has to be reduced to an absolute minimum.

The age of the earth appears very likely to be of the magnitude of $3{,}000 \times 10^6$ years, according to Holmes,[8] Houtermanns[9] and some astronomical data, and minerals of the greatest geological age yet reported are, according to Ahrens[10], from pegmatites in south-eastern Manitoba, Canada: the age of these pegmatites from this area is given as $2{,}100 \times 10^6$ years and is based on strontium and lead age measurements. These pegmatites are thus of extreme age, the magnitude of which is comparable with the age of the earth. In greisenized portions of some of these pegmatites, cassiterite occurs, and according to Itsikson and Rusanov[6], pegmatitic cassiterite is likely to be freest from the presence of even traces of indium. Consequently, a spectrochemical analysis was made of a specimen of cassiterite from pegmatite (south-east Manitoba), which had been kindly supplied by the Department of Mines and Natural Resources, Winnipeg, Canada. Only a doubtful trace of indium was observable, equivalent in quantity to the limit of detection for the spectrochemical determination of indium in cassiterite, which, with the aid of a series of standards, was estimated to be very close to 0·0001 per cent indium. This value represents the maximum concentration of indium in the specimen of cassiterite, and as the tin content of pure cassiterite is about 75 per cent Sn, the period of half-life (T) for tin-115 is equal to or greater than $5{\cdot}0 \times 10^{13}$ yr.

From this analysis of cassiterite, several conclusions may be made: (1) The relative abundance of indium-115 (95·5 per cent) in natural indium, and the paucity of tin-115 (0·4 per cent) in natural tin, cannot be attributed to electron capture decay of Sn^{115} during earth periods. (2) The presence of traces of indium in many tin minerals is not due to decay of tin-115 because, even in the oldest known specimen of cassiterite ($2{,}100 \times 10^6$ yr.), only a doubtful trace (equal to or less than 0·0001 per cent indium) could be observed. (3) Should tin-115 have decayed very feebly indeed to indium-115, the rate of decay is extremely slow, and T (Sn^{115}) is equal to or greater than $5{\cdot}0 \times 10^{13}$ yr., which accords with the observations of Rusinov and Igelnitzky[7], who determined T as $1{\cdot}0 \times 10^{15}$ yr. by direct experiment. The spin[11] of In^{115} is 9/2, whereas that of Sn^{115} is 1/2; this difference in spins is very great indeed, and should decay occur, an extremely long life would be expected.

The spectrochemical analyses were made in the Department of Mineralogy and Petrology, University of Cambridge; grateful acknowledgment is made to Prof. C. E. Tilley for providing facilities for carrying out the investigation.

L. H. Ahrens

Department of Mineralogy and Petrology, University of Cambridge. July 17.

[1] Mattauch, J., and Fluegge, S., "Nuclear Physics Tables and an Introduction to Nuclear Physics", 104 (Interscience Publishers, Inc., New York, 1946).
[2] Kohman, T. P., *Phys. Rev.*, **73**, 16 (1948).
[3] Eastman, E. D., *Phys. Rev.*, **46**, 1 (1934).
[4] Eastman, E. D., *Phys. Rev.*, **52**, 1226 (1937).
[5] Itsikson, M. L., and Rusanov, A. K., *C. R. Acad. Sci. U.R.S.S.*, **53**, 631 (1946).
[6] Zingg, E., *Helv. Phys. Acta*, **13**, 219 (1940).
[7] Rusinov, L. I., and Igelnitsky, J. M., *C. R. Acad. Sci. U.R.S.S. (Doklady)*, **49**, 343 (1945).
[8] Holmes, A., *Nature*, **159**, 127 (1947).
[9] Houtermanns, F. G., *Z. Naturforsch.*, **2a**, 322 (1947).
[10] Ahrens, L. H., *Nature*, **160**, 874 (1947).
[11] Bethe, H. A., "Elementary Nuclear Theory", 132 (John Wiley and Sons, Inc., New York, 1947).

Human Colour Vision and Granit's Theory

Granit's brilliant experiments on electroretinography[1] have led him to postulate photopic and scotopic 'dominator' mechanisms which have all the properties of independent brightness receptors, and 'modulator' mechanisms which may give cues to colour because they are sensitive to relatively narrow bands of the visible spectrum. Many of the animals on which the experiments were done, such as the cat, rat, guinea pig and frog, are totally colour blind to the best of our knowledge; and Granit points out (*a*) that most laboratory animals, with the exception of the snake, possess very few modulators relative to their dominator units; (*b*) that these proportions in the highly colour-sensitive human fovea are not known; (*c*) that the demonstration of modulator units is not in itself a proof of the presence of colour vision.

In a previous communication the factorial analysis of a battery of colour vision tests, including red, orange, yellow, yellow-green, green, blue-green, blue, violet and purple, with corresponding brightness measurements, was reported[2]. This seemed to give strong support to a four-colour theory of the Hering or Houstoun type. There is, however, every reason to suppose that such results might be co-ordinated with Granit's findings.

In a subsequent series of tests, the following results were obtained on a group of 357 subjects with normal colour vision, the brightness readings being separately inter-correlated with the measurements of colour sensitivity, though there was, of course, only a single brightness-level measurement for each colour pair, because the tests were of the Rayleigh equation type.

Test	Factor loadings I	II	III
Red	0·070	+0·787	−0·226
Yellow	0·007	+0·104	−0·451
Green	0·121	−0·683	−0·069
Blue	0·459	−0·061	+0·236
Y-blue brightness	0·179	−0·268	+0·395
R-green brightness	0·252	+0·141	+0·115

It seems reasonable to suppose that factorial analysis would tend to reveal any consistent patterns of variation in the sensitivities of the underlying visual mechanisms, and therefore to indicate their number and nature. In this analysis, as in the other analysis of the results for normal subjects[2], the first factor is light but represents general variabilities irrespective of differential hue sensitivity; the second factor is heavy and represents variability in the bipolar red-green sensitivity; and the third factor is light and represents variations in yellow-blue sensitivity. The variations of brightness sensitivity are distributed among the three factors. 'Blue' and brightness are the best representatives of the general factor; red-green brightness tends to vary with red, but yellow-blue brightness with green in the second factor; both yellow-blue brightness and red-green brightness with blue in the third factor.

It might be suggested that the general factor represents variations in the sensitivity of the dominator mechanism for photopic vision. The second factor would then represent the variations in sensitivity for the red-green modulator unit and the third factor the variations for the yellow-blue modulator unit. Three important conclusions may be drawn from this application of Granit's theory to the result of tests of colour vision upon normal human subjects: (*a*) that four modulators would be sufficient, namely,

red, yellow, green and blue; (*b*) that they must be regarded as operating in two bipolar units, red with green, and yellow with blue; (*c*) that brightness is to some extent dependent on the modulator units.

R. W. Pickford

Psychology Department,
The University,
Glasgow, W.2.
May 24.

[1] Granit, R., "Sensory Mechanisms of the Retina", Section IV (1947).
[2] Pickford, R. W., *Nature*, **157**, 700 (1946).

A Simple Technique for the Differential Staining of Lignified Cell Walls

The common methods for differential staining of lignified plant tissue are specific when used correctly, but minor errors in procedure may lead to unsatisfactory results. The following simple technique has been found a reliable, cheap and quick supplement to the other methods available, and to give good results in unskilled hands.

It is based on the observation that, in all cases which we have examined, a colourless solution of benzidine imparts an orange or yellow colour to lignified cell walls, but causes no colour change in cellulose or in cutinized or suberized walls. The most intense orange coloration is produced by a saturated solution of benzidine in glacial acetic acid. With lowered acidity the solubility of benzidine decreases, the resulting solutions producing a less brilliant but equally specific staining. This develops in sections after thirty seconds to sixty seconds treatment; but as the solution is colourless and the reaction occurs only in lignified tissue, sections can be left in it for many days without 'overstaining', and there is no need for subsequent washing or 'destaining'. This is an advantage when handling sections in bulk, it being possible to transfer them to the solution directly after cutting and to hold them in it until it is convenient to mount them with or without a light counter stain. A less acid solution may also be used for the vital staining of tissue, as vascular systems of leaves, etc., are clearly visible after impregnation. The colour is unaffected by treatment with alcohol or xylol, and has shown no signs of fading in sections exposed to daylight for three months.

In view of the constitution of benzidine, the chemistry of the staining is possibly similar to that of the colour reaction given by lignified cell walls with a number of primary and secondary amines.

Iwo R. W. Lominski
Department of Bacteriology,

S. A. Hutchison
Department of Botany,
University of Glasgow.
July, 1948

Influence of Time and Temperature of Storage on Dye-Reduction Tests in Milk

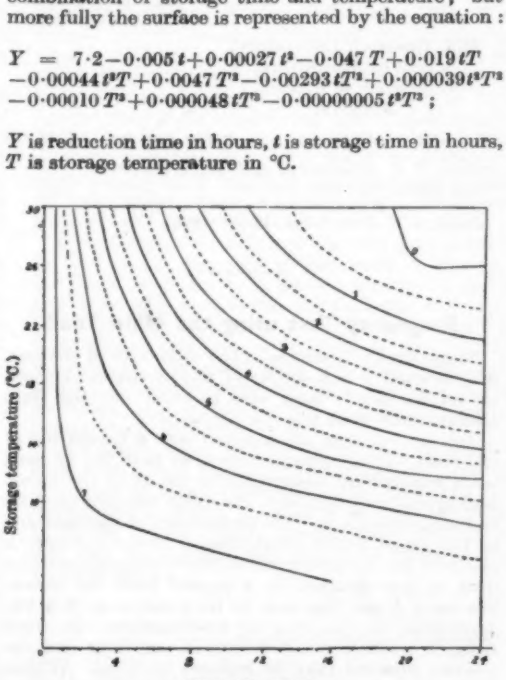
In applying overseas data to the determination of suitable dye-reduction standards for the grading of milk in New South Wales, it soon became apparent that particular attention would have to be paid to the influence of time and temperature of storage on the reduction time[1]. Apart from Smythe's work in Queensland[2], for a relatively limited storage time, there is surprisingly little information concerning the significance of these factors, and it is thought that our own approach and results will prove of interest beyond Australia.

The primary aim of our work has been to study the trends in decrease of dye-reduction times with storage time and temperature, including within the range of our experiments conditions likely to be encountered both in Australia and Britain. By this means it has been possible to bring to bear on our own problem the large body of British experimental work and practical experience, as well as to arrive at a temperature compensation scale for local variations that are likely to be more extreme than those encountered in the United Kingdom. Samples from six producers, representing extremes of production conditions, were taken at the completion of milking and stored at combinations of time and temperature, namely, 4, 8, 12, 16, 20 and 24 hr. and 0, 10, 14, 18, 22, 26 and 30° C. Methylene blue and resazurin tests (both at 37·5° C.) were then performed on each sample.

With the advice of Dr. D. B. Duncan, of this Department, it has been possible to use the results so obtained to study the trends with storage time and temperature as a regression surface, having twelve parameters and allowing for quadratic variation with storage time and cubic variation with temperature as well as interaction between the two. The results for the modified methylene blue test are shown in the form of a contour graph (reproduced herewith) in which the lines join the points of equal reduction times. From this graph it is possible to arrive at an approximation of reduction time associated with any combination of storage time and temperature; but more fully the surface is represented by the equation:

$$Y = 7{\cdot}2 - 0{\cdot}005\,t + 0{\cdot}00027\,t^2 - 0{\cdot}047\,T + 0{\cdot}019\,tT - 0{\cdot}00044\,t^2T + 0{\cdot}0047\,T^2 - 0{\cdot}00293\,tT^2 + 0{\cdot}000039\,t^2T^2 - 0{\cdot}00010\,T^3 + 0{\cdot}000048\,tT^3 - 0{\cdot}00000005\,t^2T^3;$$

Y is reduction time in hours, t is storage time in hours, T is storage temperature in °C.



Influence of time and temperature of storage on methylene blue reduction time. Lines join points of equal reduction time in hour – half-hour intervals

The surface represented in the graph and the accompanying equation appears, from a consideration of British temperatures (as recorded at Kew), to pass through the British Summer Standard (12 hr. storage at mean summer air temperature of 16° C., reduction time, 4½ hr.). However, the height of the surface can be conveniently altered by adjustment of the constant (7·2 in the above equation) to comply with any other standard.

Similar methods have been applied to data for the resazurin tests obtained on the same milks, thus permitting an accurate comparison of the time–temperature trends together with a comparison of existing British standards for both tests. Our data suggest, in fact, that the standard set for resazurin[3] is appreciably lower than that for methylene blue[4].

Furthermore, by taking account of data for the individual producers, it is possible to determine the degree of discrimination associated with each combination of time and temperature; so that the storage period can, within certain practical limits, be adjusted to obtain greater sensitivity in the test.

Other advantages of our approach might then be summarized thus. Comparable standards can be established for widely different conditions of production. A reasonable adjustment in acceptable reduction time can be made throughout the year according to temperature and time of storage, thus freeing the test of its present undue dependence on atmospheric temperature[5]. The length of time between production and testing can be allowed for in evaluating producers. The time–temperature effect can be related for several tests.

R. K. Morton
J. M. Vincent

Milk Research Laboratory,
School of Agriculture,
University of Sydney,
April 19.

[1] Morton, R. K., and Vincent, J. M., *J. Aust. Inst. Agric. Sci.*, **13**, 125 (1947).
[2] Smythe, V. R., *Queensland J. Agric. Sci.*, **2**, 128 (1945).
[3] Great Britain, Min. Agric. and Fish.: Form C.158/TPY, 1943.
[4] Great Britain, Ministry of Health, Memo. 139/Foods, 1937.
[5] Mitchell, H. H., *Dairy Indust.*, **12**, 351 (1947).

Pregnancy Test using the Male Toad

Through the kindness of the originator of the test, who forwarded us a supply of *Bufo arenarum* Hensel, we have recently been able to carry out the Galli Mainini male toad test for pregnancy.

Ten ml. of urine are injected into a lymph sac of the toad. It is important to note that the animals seem particularly susceptible to drugs in the urine. But apart from this fact, the urine samples need no special preparation. The appearance of spermatozoa in the urine, which constitutes a positive result, is observed by low-power microscopic examination of a drop or two obtained by a pipette from the cloaca. We have found the test to be positive in 2–4 hr., depending on the time of examination. In some cases, a positive result occurs in one hour and the amount injected may be reduced to 5 ml. Within 20–24 hr., re-sampling of the urine shows either absence of spermatozoa or fewer and non-motile spermatozoa. The temperature averaged 22° C. during the tests.

In a consecutive series of fifty inoculations, we have encountered no false positive and only one false negative. This latter may be explained on the basis that the urine sample was abnormally dilute. The series included gonadotrophins, cases of confirmed pregnancy, incomplete abortions, uterine fibroids, secondary amenorrhœa and normal women.

Over a limited series, we have confirmed claims made for this test by Galli Mainini[1], Lima and Pereira[2], who used *Bufo marinus*, and Wiltberger and Miller[3], using *Rana pipiens*. It remains to be seen whether *Bufo bufo* or *Rana temporaria* will be equally suitable.

Magnus Haines

Department of Pathology,
Chelsea Hospital for Women,
Dovehouse Street,
London, S.W.3.
June 15.

[1] Galli Mainini, C., *J. Clin. Endocrinol.*, **7**, 653 (1947).
[2] Lima and Pereira, *Nature*, **161**, 676 (1948).
[3] Wiltberger, P. B., and Miller, P. B., *Science*, **107**, 198 (1948).

Shortage of Scientific Text-Books

As one who is associated with a group of firms dealing with all aspects of the production, publishing and retail selling of learned, scientific and technical books, I have read with very considerable interest the article on the survey of the present shortage of scientific text-books in Cambridge carried out by the Cambridge Branch of the Association of Scientific Workers which appears in *Nature* of August 7, p. 209. Unfortunately some of the conclusions appear invalid.

That there is a shortage of text-books in this category there is no question. Under present conditions it is inevitable that in any discussion of this shortage mention must be made of the Board of Trade, so let me at once pay tribute to the officers of the Board of both the Import Licensing and Raw Materials Divisions, who have been approachable at all times, and, I am convinced, have done their utmost, often in circumstances of considerable difficulty, to ameliorate the position.

That too great a proportion of British scientific text-books has to be exported is a statement difficult to support. Export there is and must be; but there are few scientific books which are exported to an extent which harms the home market.

With regard to American books, the surveyors appear to be under one serious misapprehension. Despite what they say, it is possible for any individual requiring any American learned, scientific and technical book to go into a bookshop (preferably one with some experience of this type of work) and to order that book. If it is in print in the United States, there is no reason why it should not be in Great Britain within a month of the order being placed.

Secondly, with regard to the 200 per cent quota: this figure, taken in conjunction with the 'single copy' *modus operandi* referred to above, should be adequate to meet requirements at the present time. I agree that it is not so; but the reason lies not in the 200 per cent total figure but in the allocation of that figure on the basis of individual firms' imports during either the last half of 1939 or the first half of 1940. The reason is quite simple—in ten years the emphasis of business has altered as between firms, both book-

sellers and publishers, in Great Britain so that the ratio of supply does not fall in the regions where the requirements are greatest.

If the 200 per cent total were to be re-allocated (a difficult but not insuperable task) according to present-day demands, many of the difficulties would be eased and indeed might very well disappear, provided the 'single copy' method of working is used intelligently. This point has been put on more than one occasion to the Board of Trade who, I believe, are shackled by Treasury restrictions.

With regard to the Survey's comments on British books, there is one misunderstanding which should be got rid of immediately: for books in this category paper is no longer a restrictive factor in so far as quantity is concerned. The Board of Trade in conjunction with the Publishers' Association maintain a reserve, known as the Moberly Pool, for 'educational' books: this has been gradually increased as circumstances allow, and it has been administered with the utmost fairness and with the approbation of all concerned. After fairly extensive inquiries, I have yet to find a publisher with a sound case who has been refused an allocation which he required for a book in the categories under discussion. There still are, of course, difficulties with paper in regard to quality and price.

The only other difficulty with material is in regard to cloth. This would appear to be a difficulty not of the basic essentials being unavailable but of the output of the Lancashire mills. Again, both with cloth and with boards there are reasons for complaining of quality and of price.

The production obstacles which any publisher must confront at present are very slowly easing in the field of printing, although a shortage of apprentice entrants as compositors during the war years has caused a bottle-neck which it will take some years to overcome.

In binding books the position is bad indeed. But the lack is not of material, apart from cloth, but of machinery: nearly all of it American. The Board of Trade has been helpful in every way, but the fact must be faced that the source of supply is limited in the beginning, so long as there are so few British types of machines suitable for the work which must be undertaken.

But the main difficulty with regard to all production hold-ups is the shorter working week and the policy which has been psychologically instilled into the minds of so many of the workers that they can expect more pay for less work. This factor cannot be overstressed, and until it is remedied we can expect no real improvement in the supply of scientific text-books.

JOHN GRANT

Oxford.

MAY I be permitted three comments on Mr. Grant's letter. With regard to his third paragraph, the original article did not suggest that too great a proportion of scientific text-books is being exported. It was stated "that a good case can be made out for the large percentage of book production which goes to export". It was emphasized, however, that this trade and reputation "are in danger unless our total volume of 'learned, scientific and technical' book production is increased, so that both the home and export markets may be better supplied".

On Mr. Grant's fourth paragraph, it was specifically stated in the article that no account was taken of books imported as single copies as this factor was not thought to be important so far as students are concerned. In fact, our experience is that it takes 8–10 weeks to get such books and often longer.

If binding causes great difficulties, have the publishers considered bringing out temporary editions of some of the most needed books in an unbound form similar to *Nature* or *Hansard*. Students to-day could be relied on to treat them with due care.

ROY INNES

Association of Scientific Workers,
15 Half Moon Street,
London, W.1.

International Exchange of Scientific Information

IN the editorial article in *Nature* of August 14, in criticizing a recent statement of the Atomic Scientists' Association, it is argued that collaboration between scientific men east and west of the 'Iron Curtain' may be undesirable, because it is likely "to promote, for the present, a one-way traffic to the disadvantage of the Western democracies". This view was expressed in the same words on July 14 by the editor of the *Economist*, who, professionally concerned as he must be with economic policy and its effect on foreign affairs, may be excused for including scientific ideas among the commodities available for exchange. But the same view expressed in *Nature* suggests a change in the traditional policy of the journal, which has always stressed the international aspects of science, and it shows strikingly the way in which military considerations can affect the outlook of scientific workers and lead them to adopt against their will a totalitarian view of their function. It is therefore necessary to inquire whether these military considerations really make it necessary to abandon the whole tradition of science, and to break off such contacts as are still possible with the scientific workers of Eastern Europe.

It is stated in the editorial that the man of science in totalitarian countries is essentially a servant of the State, and that it is treason for him to divulge any knowledge save as the State allows. But in fact this statement is true only in the opinions of the men who control the Government of the U.S.S.R.; we may be sure that most scientific men in the satellite countries would not take that view of their functions, and probably many outstanding men in Russia itself hold other views.

Our policy, then, of allowing the free exchange of ideas even across frontiers is one which our scientific colleagues in these countries will feel to be the right policy, and in which we shall have their sympathy. It should not be lightly thrown away through the fear that some small help might be given to their military science.

N. F. MOTT
(Vice-President,
Atomic Scientists' Association)

H. H. Wills Physical Laboratory,
Royal Fort,
Bristol 8.
Aug. 20.

THE CORE OF THE INSULIN MOLECULE

By Dr. J. A. V. BUTLER, D. M. P. PHILLIPS
AND
Miss J. M. L. STEPHEN
S. A. Courtauld Institute of Biochemistry, Middlesex Hospital, London

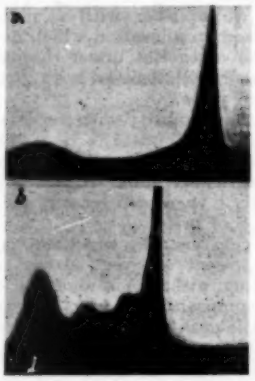
ON account of its stability and well-defined crystalline character, insulin is a favourable point at the present time to attack protein structure. Its composition is probably better known than that of any other protein. The stoichiometrical molecular weight, that is, the least weight into which all the analytical values can be fitted, is 12,000, indicating a comparatively simple character[1]. Recent researches[2] show that the most prevalent molecule in aqueous solution has a molecular weight approximately four times as great, dissociating somewhat in acid and moderately alkaline solutions. The facts, therefore, suggest that the basic unit of insulin is a molecule of molecular weight 12,000. X-ray analysis has indicated that three of these units form the unit cell in crystals[3].

Knowledge of the chemical structure of insulin has been greatly advanced by Sanger[4], by the use of the reagent fluorodinitrobenzene, which reacts with the amino-groups of proteins under very mild conditions, forming a bond which resists acid hydrolysis, so that the amino-acid residues which form the amino-end of the peptide chains can be identified. Sanger has shown in this way that the sub-molecule of insulin consists of four chains, of which two terminate in glycine and two in phenylalanine residues. These chains are presumably held together by the –S–S– links provided by the cystine, of which six exist in the molecule. Sanger has shown that by oxidation with hydrogen peroxide in formic acid solution, according to the method of Toennies and Homiller[5], these disulphide links are oxidized and a product is obtained which has been shown by adsorption analysis[6] and electrophoretic analysis[7] to consist of three or four distinct substances. A fraction was obtained from this which contained no phenylalanyl residues and contained no lysine, arginine, histidine, or threonine, and in which all the terminal residues are glycine[8].

Another line of approach has emerged from the work of Woolley[9], who has found in the partial hydrolysates of various proteins a growth-promoting factor for *L. casei* which he calls 'strepogenin'. Insulin was found to be a particularly rich source of this substance. Strepogenin appears to be a peptide which occurs in insulin at the end of one or more of the chains, since elimination of the free amino-groups of insulin with fluorodinitrobenzene destroys the activity[10]. Woolley has also found that the dinitrophenyl derivative of insulin and of oxidized insulin can be digested by pancreatin. The products have been fractionated by a series of counter-current distributions by the method of Craig[11], and several crystalline dinitrophenyl peptides obtained[12] containing, in addition to dinitrophenyl glycine, the following amino-acids: (1) glutamic acid, (2) glutamic acid, serine, threonine, valine and leucine; (3) same as (2) plus aspartic acid; (4) glutamic acid, serine, tyrosine and leucine; (5) same as (3) plus *iso*leucine and cysteic acid.

A study of the enzyme breakdown of insulin has been made by Butler, Dodds, Phillips and Stephen[13]. It was found that whereas pepsin breaks the insulin molecule into fragments with a molecular weight of *c.* 3,000 and an average chain-length of about seven residues, chymotrypsin removes from the molecule a number of smaller peptides of molecular weight *c.* 800, leaving a more massive residue which is precipitable in 0·25 *N* trichloroacetic acid. After extracting the trichloroacetic acid with ether, it was found that its molecular weight is 4,000 ± 1,500. In two separate experiments, it was found to contain between 80 and 90 per cent of the total amount of cystine of the insulin molecule. It thus appears that the result of chymotrypsin digestion is to remove parts from the ends of the insulin chains, leaving a 'core' in which the chains are united by –S–S– links. This core is slowly broken down by the long-continued action of chymotrypsin.

Attempts made to separate the smaller peptides in the trichloroacetic filtrate have on the whole been unsuccessful. Paper chromatography with phenol divided them into four broad bands[14]; but it has been found that this is at best only a partial separation,



(*a*) Electrophoretic diagram of the core material (*C*11*B*) at pH 8·0. (*b*) Electrophoretic diagram of the oxidized core (*C*11*B*) at pH 7·0. Experiments by Dr. J. M. Creeth. Ascending boundaries shown.

since eluting the bands separately and repeating the process gives a very similar pattern. Paper chromatography with butyl alcohol – acetic acid as solvent has given a series of fifteen distinct spots, most of which are peptides; but it has not so far been possible to isolate these substances in sufficient quantity for examination.

Further examination of the material precipitated by trichloroacetic acid has provided evidence of its essential homogeneity. It gives a single sharp boundary in electrophoresis (Fig. *a*). Dr. K. O. Pedersen, of the Institute of Physical Chemistry, Uppsala, has kindly determined its diffusion coefficient by the free diffusion method[15], obtaining the figures $D_A = 18{\cdot}6 \times 10^{-7}$, $D_M = 18{\cdot}3 \times 10^{-7}$ at 20°. This corresponds to a molecular weight, assuming a spherical and unhydrated molecule, of approximately 5,000. All the amino-acids of insulin are present, except possibly arginine, threonine, proline and phenylalanine, which have either been absent or shown up weakly in one of the fractions resulting from oxidation of the core.

After oxidation by hydrogen peroxide in formic acid solution, the product shows four well-defined peaks in the electrophoresis diagram (Fig. *b*). The slowest of these (left-hand peak in the diagram) may be due solely to the δ-anomaly, since this material cannot be equilibrated with the buffer by

dialysis. Their isoelectric points are below *p*H3, indicating the presence of strongly acid groups, as may be expected from the presence of cysteic acid. When the oxidized material is taken in aqueous solution to *p*H 4·5, a small fraction corresponding to Sanger's fraction *B*, but containing only 5 per cent of the material, separated. This could be shown to contain *all* the amino-acids of insulin, that is, those present in small amounts and undetectable in the whole core are concentrated in this fraction. The remainder lacks arginine, proline, lysine, threonine and phenylalanine. It is possible that the small separated fraction is a small amount of material, carried along by the core but not really belonging to it, or to a portion of core not broken down as much as the remainder. The oxidized soluble substance was also found to be complex by paper chromatography in butyl alcohol–acetic acid mixtures and showed three or four separate spots with ninhydrin.

The core can also be converted into its dinitrophenyl derivative by Sanger's method. The product, when examined by paper chromatography with phenol, gives two distinct yellow spots, a main spot and a fainter one, and is therefore apparently not completely homogeneous. Different digests behaved differently in the relative intensities of these spots, and it is probable that the core is more digested away in some cases than in others. After hydrolysis with 6*N* hydrochloric acid, the dinitrophenyl core was found (in one experiment) to yield the following amounts of dinitrophenyl amino-acids, calculated for a core molecular weight of 5,000: glycine, 2·5 molecules; with smaller quantities of valine (0·4 molecule), terminal histidine (0·8 molecule) and ε-lysine (0·5 molecule). This core was 40 per cent of the insulin molecule. Another core (36 per cent) gave glycine, 2·4 mol.; valine, 0·3 mol.; histidine, 1·7 mol. The glycine figures involve a considerable correction for the decomposition of dinitrophenyl glycine during the hydrolysis and may require revision. The fractional numbers and the variation of different cores would suggest that the core molecules are not all of the same kind.

After oxidation of the dinitrophenyl derivative, the product is divisible into two portions: (1) soluble in water, (2) insoluble in water. It has been found that the soluble portion can be separated into three bands, the first rather diffuse and the other two sharp, by passing its aqueous solution down a starch column. The insoluble fraction can be made soluble by dissolving in dilute ammonia. After neutralizing with acetic acid, it also gives three bands similar to those of the original soluble portion. Since a mixture of the soluble and insoluble parts when dissolved together also gives the three bands, it is concluded that the original soluble and insoluble portions are either made up of the same or of closely related substances. The proportions seem, however, to be different. Work on characterizing these fractions is being continued.

We have frequently observed in our work on the digestion products of insulin that a preparation became insoluble after thorough drying, and that treatment with dilute acid or alkali was necessary to bring it into solution. The removal of water apparently causes loose bonds to be established between the peptide chains, possibly through the interaction of neighbouring acidic and basic groups to form an insoluble complex, which is only broken by the application of acids or alkalis.

We acknowledge with pleasure financial assistance by Messrs. Courtaulds, Ltd., and Messrs. Imperial Chemical Industries, Ltd.; advice and assistance in characterizing dinitrophenyl derivatives by Dr. F. Sanger, the technical assistance of Mrs. I. D. R. Goodwin and the interest and help of Prof. E. C. Dodds. We are also indebted to Dr. J. M. Creeth for the two electrophoretic diagrams reproduced, and to Dr. K. O. Pedersen for his examination of the core material, details of which he is publishing elsewhere.

[1] Chibnall, A. C., *Proc. Roy. Soc.*, B, **131**, 136 (1942); Second Proctor Memorial Lect., *J. Inter. Soc. Leather Trades Chemists*, **30**, 1 (1946).
[2] Gutfreund, H., *Biochem. J.*, **42**, 136 (1948).
[3] Crowfoot, D., *Proc. Roy. Soc.*, A, **164**, 580 (1938).
[4] Sanger, F., *Biochem. J.*, **39**, 507 (1945).
[5] Toennies, G., and Homiller, R. P., *J. Amer. Chem. Soc.*, **64**, 3054 (1942).
[6] Sanger, F., *Nature*, **160**, 433 (1947).
[7] Sanger, F., *Nature*, **160**, 295 (1947).
[8] Private communication.
[9] Sprince, H., and Woolley, D. W., *J. Amer. Chem. Soc.*, **67**, 1734 (1945).
[10] Woolley, D. W., *J. Biol. Chem.*, **171**, 443 (1947).
[11] Craig, L., *J. Biol. Chem.*, **155**, 519 (1944); with others, *ibid.*, **161**, 321 (1945); **162**, 363 (1946).
[12] Woolley, D. W., *Fed. Proc.*, **7**, 200 (1948).
[13] Butler, J. A. V., Dodds, E. C., Phillips, D. M. P., and Stephen, J. M. L., *Biochem. J.*, **42**, 116, 122 (1948).
[14] Phillips, D. M. P., (In preparation).
[15] Private communication.

BIREFRINGENCE AND ORIENTATION-RATE OF THE LEPTONES OF PROTOPLASM

By Dr. HANS H. PFEIFFER
Laborat. für quantitativ Polarisationsmikroskopie, Bremen

PRESENT knowledge indicates that the submicroscopic or 'leptonic' state of organised gels[1] consists of a framework of reciprocally associated macromolecules or molecular bundles (micelles). Their orientation-rate within the gels, as observed in polarized light, decides whether there are formed anisotropic gels in which the particles (leptones) are arranged parallel to each other, or isotropic gels in consequence of perfect disorientation of the leptones. Between these two limiting cases, there are many textures with differently graded orientation-rates. If a system contains imperfectly oriented leptones, the orientation-rate, and hence the birefringence, will be increased by tension[2]. Thus the birefringence will reach a maximum when the leptones are maximally oriented. But the theoretical relation between birefringence and orientation-rate is somewhat indefinite, for even in the case of perfect orientation the rate of grid-like disposition cannot be comprehended apart from the remainder. Moreover, isotropy includes cases of perfect disorientation as well as adjacent organisation in the immediate environs (*Nahordnung*). Further complications in consequence of different rates of swelling and extension cannot be taken into consideration here. The distribution function of O. Kratky, P. H. Hermans and coworkers[3], defining the frequent repetition of the different directions of leptones, has been obtained from the extension-rate of the gels and their orientation state *before* the extension. But with biogels, the deformation-rate during the unextended, that is, isotropic, state is not appreciable. Frey-Wyssling[4] has derived expressions describing the field or cone of scattering of leptones by means of a single angle. This method, however, gives only a comparative measure of the increase of orientation. I have now been able to investigate the *streaming birefringence* of protoplasm and to calculate the orientation-rate of its leptones.

By means of much improved experimental arrangement, it has been shown that protoplasm sucked up into a capillary becomes doubly refractive if it is made to flow by a compressing force[3]. Continuing these experiments[4], the birefringence has been found to be negative with regard to the flow direction. Hence, evidence is available that the effect first described by Pfeiffer is produced by lipids of the protoplasm. The interpretation of the experiment is perhaps doubtful, and we do not know whether, by sucking up the material, the protein chains are straightened out and the lipids have to follow the orientation, or whether the lipids, by the interlocking, are released and become able to arrange themselves parallel with one another. But the flow experiment with protoplasm makes it possible to evaluate the *maximal* streaming birefringence, and hence a given orientation-rate, and to make other measurements (for example, length of leptones, to be described shortly elsewhere).

For the quantitative study of the birefringence of protoplasm flowing within a capillary, the latter has been embedded in a liquid of the same index of refraction as the protoplasm[5] (about 5 mm.[3] of the *Physarum polycephalum* plasmodium grown on oat agar). A detailed description of the apparatus and the method of stimulating the flow have been published already. The quantitative studies relate to the character (sign) and the phase difference (intensity) of the anisotropy of protoplasm, and to its direction of extinction. If, as with protoplasm, long-chain molecules are not oriented at 45° to the gradient of flow, but at angles between 45 and 90°, it is necessary to define the direction or *angle of extinction*, χ (*Auslöschwinkel*, angle of isocline, *Kreuzwinkel*). For this purpose we find the orthogonal position of the crossed nicols in a lateral, extinguished flame of the capillary[6]. The flow capillary is fixed and the optical polarizing equipment adjusted as a whole; then the angle required results from the extent of the turning movement against the direction referred to. The *negative sign of anisotropy* results from the use of a Red I (gypsum) plate oriented, like the object, with its direction of fast and slow transmission at 45° to the planes of polarizer and analyser, and, as usually employed, the slower vibration direction (larger index) extending from the upper right to the lower left quadrant of the field of view. The *phase difference* of the object (Γ) has been measured with a very sensitive Brace compensator (rotating $\lambda/30$-mica compensator) and the half-shadow wedge according to Macé de Lépinay at varying velocities of flow[7]. The polarizer is set at 0°, the object brought into focus and oriented in a diagonal position (45° to the polarizer plane), and the compensator and the analyser are inserted (nicols crossed). After the compensator has been adjusted so that the field surrounding the object is maximally dark and the angle noted (average of five to ten readings), the compensator is then moved round so that the object is maximally dark (five to ten readings again). If the difference between the two series of readings is β, then the retardation is $\Gamma = (\lambda/3\,\imath)\sin 2\beta$, and the birefringence, as usual, $\Delta n = \Gamma/d$, where d is the thickness of the preparation.

In regard to the rate of orientation, it is necessary to mention especially the *extinction angle*, χ. As usual, it increases with the flow gradient and the viscosity, and decreases as the temperature goes up; but above all, it depends upon the length of the leptones. The extinction angle has been found to have values between 61° and 76°. For each series of experiments with successively increased shearing forces, the angle shows a constant value over the period during which the preparation could be kept free from denaturation. For smaller flow velocities smaller values of χ are found, which, however, are well reproducible and do not show any ageing effects. Sometimes the measured values show more scatter than could be expected from an estimation of the usual experimental errors. Hence this scattering must be due to variations in the origin and nature or special character of the material. If the same measurements are taken by varying the λ (using a cadmium spectral lamp or a perfect monochromator), with other conditions constant, a similar set of characteristic curves is obtained.

The movability of the protoplasmic leptones is measured, according to Boeder[8], by the *rotation diffusion constant*, D_R. The quotient of the gradient of flow dv/dn and of D_R represents the parameter α, which is related to a precise *direction density* ρ. If α is increasing, the maximum of the accumulation is displaced to higher χ-values. The gradual transition from lower to higher χ-values, depending on the decreasing gradient dv/dn, takes place, of course, the earlier the lower D_R is obtained. Using only one measurement of χ at a known gradient dv/dn, the constant D_R and the parameter α are, theoretically, measurable with protoplasm double refractive by flowing.

By measuring the *phase difference* Γ at an extinction angle χ sufficiently far from 45°, we are able to calculate the *maximal birefringence*, that is, the double refraction in case of orientation of all the leptones. With regard to the coefficient μ, with which we have to multiply the measured phase difference, in order to obtain the saturation value of birefringence, we find:

χ	50	55	60	62½	65	67½	70	72½
$\Delta_{Mess.}/\Delta_{max.}$	0·09	0·15	0·23	0·28	0·35	0·40	0·44	0·48
μ	11·1	6·7	4·3	3·5	2·9	2·5	2·3	2·1

χ	75	77½	80	85
$\Delta_{Mess.}/\Delta_{max.}$	0·51	0·54	0·56	0·61
μ	1·9	1·8	1·7	1·6

We have, however, to accept the limitation to the *plane* problem; the three-dimensional problem does not seem to be capable of solution with our present knowledge. With this restriction, only a limited number of leptones become arranged parallel with the direction of flow; calculation indicates 20–30 per cent, and for very long chain molecules only 3–5 per cent. Further complications are to be expected if the leptones should be deformed by the flow[10].

[1] Schmitt, Fr. O., "Medical Physics", 1586 (Yearbook Pub., Chicago, 1944).

[2] Pfeiffer, Hans H., *Kolloid-Z.*, **100**, 254 (1942); *Z. Naturforsch.*, **1**, 461 (1946).

[3] Pfeiffer, Hans H., *Nature*, **138**, 1054 (1936).

[4] Pfeiffer, Hans H., *Physics*, **7**, 302 (1936); Fujii Jubil. Vol., 701 (Tokyo, 1937); *Verh. D. Zool. Ges.*, **39**, 106 (1937); "Experimentelle Cytologie", 35 *et seq.* (Chron. Bot. Co., Leyden, 1940); *Protoplasma*, **34**, 347 (1940); "Siegeszug der Mikroskopie", 47, 55 (Frankf. M., Hauser Press, 1944); *Ber. Oberhess. Ges. Natur- u. Heilk.*, **28**, 32, 42 (1948). See also Seifriz, William, *Science*, **88**, 21 (1938). Frey-Wyssling, A., "Submikroskopische Morphologie des Protoplasmas", 73 (Gebr. Borntraeger, Berlin, 1938); Schmidt, W. J., *Erg. Physiol.*, **44**, 27, 74 (1939); Duspiva, Fr., in Nord, F. F., and Weidenhagen, R., "Handb. d. Enzymologie", 34 (Akadem. Verlagsges., Leipzig, 1940).

[5] Peterlin, A., and Stuart, H. A., in Eucken and Wolf, "Hand- u. Jahrb. d. Chemischen Phys.", **8**, Abschn. 1, B, 86 (Akadem. Verlagsges., Leipzig, 1940).

[6] Björnståhl, Y., Dissert., 145, Fig. 45 (Uppsala, 1924).

[7] Schmidt, W. J., "Handb. biol. Arbeitsmeth.", (V), **10**, 435, 535 (1934). Pfeiffer, Hans H., "Das Polarisationsmikroskop als Messinstrument in Biologie u. Medizin" (in the press) (Friedr. Vieweg and Sohn, Braunschweig, 1948).

[8] Boeder, P., *Z. Phys.*, **75**, 258 (1932). Philippoff, W., "Viskosität der Kolloide", **13**, 18, 394, 415 (Th. Steinkopff, Dresden und Leipzig, 1942). Peterlin and Stuart, *l.c.*, 81.

[9] Cf. Rashevsky, N., "Advances and Applications of Mathematical Biology" (University Press, Chicago, 1940).

[10] Taylor, G. I., *Proc. Roy. Soc.*, A, **146**, 501 (1934). Tomotika, S., *Proc. Roy. Soc.*, A, **150**, 322 (1935) and **153**, 302 (1936).

CARNEGIE INSTITUTION OF WASHINGTON

THE feature of most general interest in Dr. Vannebar Bush's report as president of the Carnegie Institution of Washington for the year ended October 31, 1947 (Year Book No. 46), is his review of the range of the Institution's activities, and particularly the relation of the Institution to Federal support. Dr. Bush points out that the Institution has always recognized that research stands or falls by the men who are responsible for its prosecution, and from its earliest days has consistently sought the exceptional man and provided him with facilities and resources to pursue problems which he discerned and by his own methods. Latterly, in establishing its own research centres, the Institution has recognized that such centres are of ultimate value in the search for knowledge only as they are utilized by groups of investigators including leaders of proved skill and acumen and younger men of real promise. Dr. Bush pays a high tribute both to the creative work of the Institution's scientific staff, and is also satisfied with the general plan of organisation of the work and with the effectiveness of its administration. Discussing next the termination at the end of the War as expeditiously as possible of all research for the Government, to enable the Institution to return to its own programmes of fundamental research and its policy of free dissemination of results, he considers the policy of the Institution of not seeking broad support for its research from federal funds in the light of the increasing support of fundamental investigation from Government funds.

Dr. Bush considers that the policy governing grants by the National Government for fundamental research has so far been characterized by vision and wisdom, and that it is highly important the federal policy should continue. Acceptance by the Carnegie Institution of such funds for enlarging its research programmes should depend first, however, on any such research activity forming as nearly as possible an integral operative and administrative unit, or that the activity can be terminated easily if the support terminates. The activity should, moreover, be one both intrinsically worth while and a natural addition to the Institution's own regular programme. It should also be one to which the Institution can genuinely contribute by reason of the skills and operations of the regular staff and the presence of the regular programme. Finally, the conditions under which the Institution accepts such funds should in no way infringe the independent status of the Institution in pursuing its own regular programme of research, and they should be genuinely adapted to the prosecution of fundamental investigation of the highest quality.

In reviewing the research activities of the past year, Dr. Bush notes that 1946–47 was the first since 1940 in which all departments and divisions had been fully engaged on normal programmes. Continuing his investigation at Mount Wilson Observatory of the general magnetic fields of stars, Dr. H. Babcock has surveyed likely stars down to the sixth magnitude, finding magnetic fields stronger than 1,000 gauss in several and a polar field of 5,500 gauss in one. At the Geophysical Laboratory, the development of a new type of pressure apparatus has facilitated the study of equilibrium relations in hydrous mixtures. In the magnesia – silica – water system, all the common natural hydrous silicates of magnesia, as well as two anhydrous silicates, could be prepared with only the solid phases and vapour present. Equilibria up to 900° C. at pressures up to 15,000 lb. per square inch and at 800° C. up to 30,000 lb. have been determined. New procedures developed in the Department of Terrestrial Magnetism have indicated that, within the accuracy of the measurement, the strength of the magnetic field of the earth has not changed during the past 30,000 years. A large increase in the intensity of cosmic radiation at all observing points except at the equator was observed at the time of a marked solar flare and radio blackout on July 25, 1946.

Extensive study of a wide variety of plants in the Division of Plant Biology indicates that the chloroplast pigments essential in the photosynthetic apparatus of all plants have changed but little in the evolution both of the species in major taxonomic groups and of the main groups themselves. The active pigments of present-day green algæ are thus the same as those possessed by their fossil ancestors, and results obtained in the further study of the unicellular alga *Chlorella* have shown that while the chemical composition of the alga varies widely with the culture conditions selected for its growth, the nature of the chlorophyll pigments is unchanged. The grass-breeding programme of the Division of Plant Biology undertaken in co-operation with the Soil Conservation Service of the United States Department of Agriculture has yielded hybrids of high promise owing to their combination of favourable yield, resistance to disease and continued activity in dry summer weather. The species used in the crossings produce most of their seed asexually but, unexpectedly, it was found that two-thirds of the hybrids between asexual parents were themselves sexual.

The aerosol method developed in the Department of Genetics for investigations involving the treatment of *Drosophila* with chemical solutions has been used for testing the power of various carcinogenic agents to effect mutations in genes. Most of the carcinogens thus tested were mutagenic, and most substances related chemically to the carcinogens but not themselves carcinogenic did not produce mutations. Dr. Dobzhansky's work in the same Department has shown that the proportion of certain types of *Drosophila* in wild populations changes with the season. The fly thus shows substantially the same kind of differentiation into altitudinal races as Drs. J. Clausen, D. D. Keck and W. M. Hiesey, of the Division of Plant Biology, found for species of *Achillea*.

In the Department of Embryology, Dr. L. B. Flexner and his colleagues, using radioactive sodium and heavy water, have obtained further evidence that the ratio of water within the cells of newborn infants to extracellular water increases as growth proceeds, and further studies of the permeability of the placenta are being pursued. Dr. S. R. M. Reynolds is investigating the physical forces involved as the uterus accommodates itself to its growing contents, as a contribution to the fuller understanding of the problems of advanced pregnancy and of parturition.

More detailed accounts of the investigations in progress or completed during the year are to be found in the departmental and divisional reports which follow that of the president, and to which bibliographies are appended. From this it is only possible to select a few further investigations for mention,

such as the attention being given by the Geophysical Laboratory to thermal measurement and to studies on radioactivity, and by the Department of Terrestrial Magnetism to studies of the earth's crust and of the upper atmosphere as well as to cosmic ray research. A feature of this report is the review of the magnetic survey and observatory programme of the Department over the period 1904–46. In the Division of Plant Biology, investigations on the chemistry of chlorophyll formation have been extended to include analysis of the process at different temperatures, and in that of Embryology tests have been made of the action of a large series of dyes related to Nile Blue on tumours in mice. Full accounts of work on the organisation of the chromosome, of cryptogenetic studies of maize and *Neurospora*, of chromosome studies on gall midges, and of work on mouse leukæmia and on the genetic structure of natural populations are included in a long report from the Department of Genetics, while that from the Division of Historical Research deals with the results of the expedition to Bonampak, in Chiapas, Mexico, the field work in the Guatemala highlands and the preparation of a hand-book of ceramic technology for archæologists and a preliminary analysis of Usulatan ware.

INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION

A MEETING of the European Continental Section of the International Committee for Bird Preservation held in Paris during July 17–20, under the chairmanship of Dr. Boje Benzon, was attended by representatives of Austria, Belgium, Denmark, France, Great Britain, Hungary, Italy, Netherlands, Norway, Sweden and Switzerland; though the German National Section has not yet been reorganised, the interests of that country were represented by the chief game warden of the British Zone accompanied by a German adviser and by a German adviser from the American Zone. The president of the Zoology Section, International Union of Biological Sciences, and an observer from the Natural Sciences Section of Unesco attended, and the Conseil International de la Chasse was also represented.

The chief business of the Conference was the discussion of proposals for the revision of the Paris Convention of 1902 for the Protection of Birds Useful to Agriculture, on which the International Committee for Bird Preservation commenced work thirteen years ago. In 1935 representatives of the Finnish, Norwegian and Swedish Governments drew up a Draft Convention for the International Protection of Birds which was presented at a Conference of the International Committee for Bird Preservation held in Brussels that year. After due consideration it was decided at this Conference that an entirely new Convention was not practicable and that proposals for the revision of the Paris Convention of 1902 should be put forward. Lord Justice von Seth (Sweden), on behalf of the Scandinavian countries, accepted this suggestion with the proviso that the broad outlines of the Scandinavian proposals should be maintained. The matter was then referred to an International Sub-Committee consisting of M. A. Chappellier (France), (the late) Dr. Percy Lowe (Great Britain), Prof. M. Siedlecki (Poland) and Lord Justice von Seth (Sweden), with Miss Phyllis Barclay-Smith (Great Britain) and M. Leon Lippens (Belgium) as secretaries. Each national section in Europe was then requested to send to the secretariat suggestions relating to the modification of the Paris Convention. The Sub-Committee, taking into consideration the views of all countries, drew up these suggestions into a general report to serve as a basis for the discussion of a definite final proposal.

The report of the Sub-Committee was discussed at a conference in Vienna in 1937, attended by representatives of twelve European national sections, and proposals for a revision of the Paris Convention agreed. The necessary diplomatic steps to bring these proposals to the attention of the Governments concerned were in progress on the outbreak of war.

However, at a conference held in London in June 1947, attended by representatives of fourteen European national sections, it was decided that in view of the many changed circumstances during ten years, the Vienna proposals were in need of further revision. The matter was again referred to an International Sub-Committee consisting of Dr. Boje Benzon (Denmark), M. G. Olivier (France), Mr. R. A. H. Coombes (Great Britain) and Dr. J. H. Westermann (Netherlands), with Miss Barclay-Smith and M. Lippens as secretaries as before. This Sub-Committee met in Brussels in November 1947 and drew up recommendations which were forwarded to all the national sections of Europe for their comments before being discussed at the Paris Conference in July 1948.

The proposals for the revision of the Paris Convention, 1902, agreed upon at this Conference meet not only the changed conditions and circumstances but also the change in outlook during the course of nearly fifty years. Whereas the Paris Convention was designed to afford protection to birds useful to agriculture (with emphasis on the small insectivorous birds), the scientific, educational and æsthetic aspect of bird life is now recognized, and in point of fact, at the present day, the larger birds are in need of as much, if not more, protection than the small insectivores. Therefore, the fundamental basis of the present proposals is that all birds should have some measure of protection. Far more is known about migration than was the case in 1902, and the countries are becoming more and more aware of their interdependence and obligations towards each other in this matter; it is now appreciated that it is not possible for the country in which migratory birds breed to maintain the stock unaided. The broad outlines of protection now proposed are that birds should be protected during their breeding season and, so far as migratory species are concerned, during the times of their *return* to their nesting grounds; also that birds in danger of extinction should have special protection. Allowance for exceptions is made when and where necessary in the interests of agriculture, forestry, fishing, science, education, etc., and for the special economic conditions in certain regions. It is also realized that the all-important balance of Nature should be maintained in every way possible, and that any bird which may constitute a menace to other species must be kept in check. The sentimental idea of a 'sanctuary' for all species where everything is inviolate is, in fact, no sanctuary, and there have been far too many instances of this: to take one example, tern colonies have almost disappeared under the onslaught of gulls, to whom an all-embracing 'protection' has afforded an undue advantage.

Import, export, transport, selling or buying are also dealt with in regard to species taken illegally, and eggs are considered equally with the birds themselves.

Certain methods for the mass capture or destruction of birds are condemned. This is a particularly difficult subject owing to old-established customs and widely diverging points of view and national temperaments. What is regarded as a normal state of affairs in one country may be deplored by its neighbour, and it is not easy to arrive at a general agreement, a tolerant give and take and gradual change being the only solution.

A point which was of no great importance in 1902, but which has become of vital importance in 1948, is the safeguarding of habitat which is the fundamental for the existence of any species of bird; with the rapid spread of civilization this is becoming more and more serious so far as all forms of wild life are concerned.

In addition to the Convention another important question dealt with by the Paris Conference was the International Inquiry into the status of the Anatidæ in Europe, and the progress being made in the various countries regarding this. The British Section, which has been allocated the task of correlating the information sent in from all over Europe, presented a report on the arrangements being made to carry out this work.

Other matters discussed were the conditions of transport of birds by air, a biological station on the Neusiedlersee in Austria, and the publication of the second edition of an International Ornithological Dictionary by Denmark.

The membership of the International Committee now numbers thirty-five, Iceland having been the latest country to form a national section. The headquarters are at the British Museum (Natural History), London, with further secretariats in Brussels and New York.

BIOLUMINESCENCE

THE increasing use of the fluorescent lamp in recent years has served as a stimulus to the study of the mechanism of the emission of cold light; and this in turn has led to a renewed interest in the production and utilization of such light in luminous animals. The Section of Biology of the New York Academy of Sciences held a Conference on Bioluminescence in November, 1946, and the papers submitted, which have now been published[1], provide a comprehensive review of the subject.

In a general survey, E. Newton Harvey points out that about forty different orders of plants and animals, ranging from bacteria to fish, contain self-luminous species. A few of these, such as the fish *Photoblepharon* and *Anomalops*, make use of luminous bacteria housed in special pouches which can be covered or exposed at will by a sort of eyelid. Chemiluminescence in general is reviewed by R. S. Anderson. Colour, fluorescence and chemiluminescence are probably degrees in an analogous process. Emission results from the loss of a quantum of energy during the change from an excited electronic state to a ground-state with less energy, these changes being independent of high temperature. Only in comparatively recent years, with the discovery of the bright chemiluminescence of aminophthalhydrazide and dimethylbiacridinium nitrate, have systems been obtained which can rival in luminosity the substances extracted from living organisms. It was in 1886 that Dubois first demonstrated that light production in animals results from the interaction of luciferin and the enzyme luciferase. In the Ostracod *Cypridina* these two components are discharged in the form of granules from separate glandular pores and then interact in the sea water. This animal, therefore, affords ideal material for the study of these substances *in vitro*, and the recent work in this field is reviewed by A. M. Chase. The structure of luciferin has not been fully elucidated; but there is evidence that it has a relatively small molecular weight and contains a hydroxybenzene structure which is reversibly oxidized to a quinone. F. H. Johnson and H. Eyring discuss the action of pressure, temperature and drugs on the enzymes concerned in bacterial luminescence.

By far the longest paper is by J. B. Buck, who provides a comprehensive review of the anatomy and physiology of the light organ of fireflies and contributes some new suggestions on the control of light emission. There is the utmost diversity in the anatomy of the light organ in the beetles; their histology ranges in complexity from a group of loose independent giant cells, apparently without tracheæ, similar to, and perhaps identical with, the œnocytes (such as occur in *Phengodes*), to the highly complicated arrangement in *Photinus* or *Luciola* where a reflective layer containing urate granules underlies the photogenic layer. In the most complex type a rich supply of tracheæ runs vertically through the reflective layer and then enters specialized cylindrical rods of tissue which pass straight through the photogenic layer. Here they give off lateral branches which end in conspicuous tracheal end-cells by breaking up into the tracheoles which supply the photogenic cells. Buck is satisfied that the tracheoles do not enter the cells; but there is evidence that they are connected together by an ultra-tracheolar network which may, perhaps, consist of open tubes.

It is this very highly evolved system which provides some of the most intriguing problems in the physiological control of luminescence. Light may be emitted as a steady glow or in the form of brilliant flashes showing a remarkable periodicity which is under the control of the organism. It is the control of flashing which has excited most controversy. There is no doubt that the organ is supplied by nerves which stimulate it to activity. It is equally sure that the production of light is dependent upon the access of oxygen to the photogenic cells. Argument has centred around the question whether the cells are stimulated directly to produce light—perhaps by the dissolution of barriers which normally separate the enzyme from its substrate—or whether the nerves control the access of oxygen. It is well known that the endings of the tracheoles in many insects contain liquid which may be absorbed into the tissues during activity and so replaced by air. It has been suggested that the enhanced oxygen supply which then results may be the cause of the light flash; but, as Buck points out, if this change does occur in the tracheoles of the luminous organ it is more likely to be secondary to the metabolic activity of the cells. The tracheal end-cells, an enlarged form of the cells which occur in many insects where the tracheæ break up into tracheoles, are a characteristic feature of the flashing type of organ. It has often been suggested that they

[1] *Annals of the New York Academy of Sciences*, **49**, 327 (1948).

play some part in the process. Dahlgren described what appeared to be a sphincter around the tracheole at this point, and beyond it a structure with radiating fibres. Buck outlines a reasoned hypothesis according to which the glowing of the organ is dependent on the diffusion of oxygen into the tracheoles, while the flashes are due to the mechanical projection of 'jets' of air into the tracheole by the controlled relaxation and contraction of the sphincter mechanism in the tracheal end-cell. But he concludes that the evidence at present available is insufficient to decide between this hypothesis and that of direct nervous stimulation of enzymic activity in the photogenic cells.

V. B. WIGGLESWORTH

SYMPOSIUM ON SEARCHLIGHTS

ONE of the most important features of a scientific society is its capacity to arrange a symposium on a special feature of its activities and to publish the resultant papers. There are many subjects where the interested people are too few for the probable financial return to tempt an author to the publication of a book, and where in addition the knowledge is so specialized that no one author can easily do justice to it. The publication under review* is such, and the Illuminating Engineering Society deserves the thanks of those who, either as user or manufacturer, need to know about searchlights in some detail. The scope of the book is indicated by the sectional headings: "The Function and Design of Army Searchlights", by E. W. Chivers and D. E. H. Jones; "High-power Searchlights of Wide Divergence", by Air Commodore W. Helmore, H. K. Cameron, F. S. Hawkins, L. B. W. Jolley and L. M. King-Brewster; "Photometry of Searchlights", by H. K. Cameron, E. H. Rayner, E. R. Thomas and G. T. Winch; "The Visibility of Targets in a Naval Searchlight Beam", by W. D. Chesterman and W. S. Stiles; "Some Visibility Problems Associated with Anti-Aircraft Searchlight Beams", by S. S. Beggs and J. M. Waldram; "Aircraft Searchlights for Anti-Submarine Warfare", by Commander G. J. Carr.

There are, in addition, some twelve pages of discussion.

The meeting was held in London on April 15, 1947, and presumably the difficulties of post-war publication are responsible for the delay in the appearance of the book.

As the titles suggest, there is a marked war-time flavour about the publication, although some of the work was carried out before 1940 but has not previously been made available to the scientific public. The balance between the historical background of searchlight design, theory and photometry, and the immediate foreground of practical war-time development has been well maintained, and the result is a record which will find a place in many industrial and technical libraries.

It may come as a surprise to many that an increase in intensity of a searchlight from 100 megacandles to 500 megacandles only increases the range by some 50 per cent in clear weather and by only some 15 per cent in medium weather. One may therefore be allowed to wonder whether the effort put into the development of the larger sizes of searchlight was justified, especially as it meant the complication of additional spare parts.

Probably the part which will attract most attention is the description of the design and manufacture of high-powered projectors for such special purposes as the interception of night-flying aircraft and submarines lying on the surface of the sea. The 'Turbinlite'—to use the war-time code word—as finally designed consumed 140 kw. with a 90-cm. mirror and was supplied by batteries which could operate for four periods of 30 sec. The whole was carried in the nose of an aeroplane, and the success of the scheme was demonstrated on many occasions. Figures are also quoted for the 'Leigh Light'—used against submarines—showing that the number of U-boats seen was increased sevenfold by its use and that 11 per cent of all night attacks carried out by its use resulted in 'kills'. The specialist in photometry will find summaries of considerable value, of both theory and practice as applied to these mammoths of the illuminating engineer's industry, much of it available in convenient form for the first time. In the case of 'visibility', many of the problems only became urgent under the stress of enemy action. Some of the solutions are especially neat, such as the 'perspective' explanation by Beggs and Waldram of the case of the apparent sudden ending of a searchlight beam to an observer near the projector.

There are a number of errors and misprints which may cause difficulty, as, for example, p. 44, Fig. 17(*b*). The symbols θ and ψ appear to be interchanged. P. 45, third line, this expression has been disarranged in the printing. P. 133, in the formula the symbol φ has been omitted after K in the square brackets.

The book provides in a convenient form a technical treatise on its subject and, in addition, a record of war-time achievement of which the various authors have reason to be proud. The diagrams and pictures are clearly and well produced; but an index would have increased the reader's pleasure and the utility of the production.

W. M. HAMPTON

* Searchlights. A series of five papers, with the discussion on those papers and a further written contribution. Pp. 164. (London Illuminating Engineering Society, 1948.) 17*s.* 6*d.* net.

AFFORESTATION FOR BENGAL

ANYONE who has travelled by railway throughout India must have noticed the disparity reigning in the distribution of the forests in that country. In some parts the railways pass through great and apparently interminable tracts of forest and jungle. In others, of which Bengal forms one of the best of examples, the converse is the case. Between Calcutta and the foot of the Darjeeling Hills the traveller by railway passes over a great plain devoted mainly to the production of rice, the villages mostly in groves of palm trees, but a total absence of forest. The forest part in Bengal represents only 0·07 acre per head of population. Bengal has only 9 per cent of its surface under forest, and a considerable part of the latter is in the Darjeeling Hills and the Sundarbans south of Calcutta.

Modern conditions and demands resulting from the Second World War, to some extent, and the great necessity to improve the agricultural soils of the Province, have at length roused the authorities. These soils are not manured. The large quantities of cow dung obtained from the great herds of cattle kept by the villagers are at present, and have been for many centuries past, utilized as fuel for heating

and cooking purposes. One of the objects of the projected afforestation plan for Bengal is to create plantations suitably distributed to provide fuel for these purposes and thus release the manure for its proper use. A Bill for the purpose of afforesting of waste lands and for conserving what is left of private forests was introduced in the Bengal Assembly in 1944. The Bill was enacted in April 1945, and already considerable progress has been made so far as private forests are concerned.

Here we have somewhat similar provisions to the Dedication of Woodlands scheme in Britain (*Nature*, Sept. 4, p. 364). The Bengal Government has the power and the duty of telling the owner how to use his forests, and the Government will meet all expenditure for the first ten years, and in certain cases and conditions the Government may make loans to private owners. As regards the waste land, the estimated area which should be, and could be, afforested is four million acres or 9 per cent of the area of the Province. If this area was afforested Bengal would then have no less than 18 per cent of its lands under forests. Much of this area, it is said is, above the paddy fields and is of a highland nature. It is said to have been under forest once, but with the forest removed soil deterioration, leaching and erosion resulted. Yet the land is believed to be afforestable. It is a big scheme and one which will make high demands on the forest staff of the Province in all its ranks.

In the paper read by Mr. T. M. Coffey, chief conservator of forests, before the members of the Rotary Club, Calcutta, in 1947 (reprinted in *The Indian Forester*, **73**, No. 11; November 1947), it is said that to carry out the programme will require to have a forest officer in every district in the Province. At present there are ten districts with forest officers and seventeen without. There can be little doubt that this is a thoroughly sound scheme—but it will require pluck, perseverance and drive and continuity in management and working to see its successful completion. If this is fully recognized, enormous benefits will be conferred upon future populations in the Province.

E. P. Stebbing

THE B.B.C. QUARTERLY

In April 1946 the British Broadcasting Corporation inaugurated a new periodical entitled *The B.B.C. Quarterly*, which was intended for those in Great Britain and abroad who are interested, professionally or otherwise, in broadcasting and its organisation. During the past two years the successive issues of this journal have contained articles on a wide variety of subjects connected directly or otherwise with the purpose of broadcasting and its administration, and with the technical and radio engineering developments which are necessary for the ever-increasing needs of modern broadcasting, including its international aspects.

More than half the contents of the first number of the third volume, issued in April, comprises a series of articles by specialists introduced and edited by Sir Arthur Salter under the general title of "The Impact of Broadcasting on Great Britain's Life and Outlook—I". The remainder of the issue consists of three articles dealing with some present-time activities of the engineering sections of the B.B.C.

In the first article, Messrs. H. B. Rantzen and J. H. Holmes describe the proposed developments which are now being undertaken to provide adequate communication facilities, mainly telephone and teleprinter, over the whole network interconnecting London and the regional broadcasting centres in Great Britain. Following this, Mr. L. Hotine gives an interesting, illustrated account of the engineering arrangements which were made for broadcasting the Royal Wedding. On this occasion, commentaries and eye-witness accounts of the processions and marriage ceremony were made in forty-two languages for the B.B.C. Home, European and Overseas Services. Provision was also made for such accounts to be given to more than fifty stations and networks in the Dominions and Colonies, and for similar facilities to be provided for the big networks and independent stations in the United States and in various European countries. Certain limited television programmes were also provided; and the success of all these arrangements is a tribute to the efficiency of all those concerned with this phase of the operation of outside broadcasting technique.

The third article deals with a subject of great and increasing importance in modern broadcasting: the suppression of unwanted radiation from medium-wave transmitters. Mr. J. B. Webb describes the manner in which spurious radiations from transmitters can, by harmonics or combination frequencies, cause interference with other broadcasting services. This possibility has become more serious in recent years, due to the increase in both the number and power of stations in operation in the medium wave band. The identification and attenuation of existing spurious radiations is often expensive and complicated, requiring the use of widespread technical facilities. But it is very clear that careful consideration should be given to possible unwanted radiations before a new service is introduced, or an increase in power contemplated at an existing installation.

FORTHCOMING EVENTS

Saturday, September 11

British Association for the Advancement of Science, Division for Social and International Relations of Science (at the Dome, Brighton), at 7.30 p.m.—Discussion on "Science Across the Frontiers". (Dr. Julian Huxley, F.R.S.: Introduction; Dr. Joseph Needham, F.R.S.: "Origins and Development of the Organisation of International Scientific Co-operation"; Prof. Pierre Auger: "Present Scientific Activities and Programme of UNESCO"; Dr. Paulo Carneiro: "The International Research Institute of the Hylean Amazon").

Sunday, September 12

British Association for the Advancement of Science (at the Dome, Brighton), at 8 p.m.—Rt. Hon. Viscount Samuel, P.C.: "Science and Philosophy".

Monday, September 13

British Association for the Advancement of Science (at the Royal Pavilion, Brighton), at 8 p.m.—Prof. J. D. Bernal, F.R.S.: "Waves and Beaches".

Monday, September 13—Tuesday, September 14

Society for General Microbiology (at the University, St. Andrews).—Scientific Papers.

Monday, September 13—Friday, September 17

Horticultural Education Association (at Edinburgh).—Autumn Conference.

Wednesday, September 15

Royal Institute of Chemistry (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. A. J. Turner: "Research on Linen".

Thursday, September 16

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. C. von Fürer-Haimendorf: "Wealth and War among Two Himalayan Tribes".

Friday, September 17

SOCIETY OF LEATHER TRADES' CHEMISTS (in the New Chemistry Building, The University, Leeds), at 2 p.m.—Mr. G. S. Adair, F.R.S.: "Recent Work on Osmotic Pressures, Membrane Equilibria and Solubility Factors of Proteins in the Light of the Work of Procter" (Third Procter Memorial Lecture).

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE AND NORTH-EAST COAST SECTION (in the Chemistry Department, King's College, Newcastle-upon-Tyne), at 3 p.m.—Symposium on "Polarography and Infra-Red Spectroscopy".

Friday, September 17—Monday, September 20

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at Ashorne Hill, Leamington Spa).—23rd Annual Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER, and an ASSISTANT LECTURER, with special qualifications in ORGANIC CHEMISTRY, and a LECTURER IN PHYSIOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (September 18).

TECHNICAL OFFICER, State Advances Corporation of New Zealand, Wellington (with a university degree, or its equivalent, in Applied Science, and a thorough knowledge of timber entomology, timber pathology and timber preservation)—The Official Secretary, High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 25).

LECTURER IN GEOLOGY, within the Department of Agricultural Chemistry, and an ASSISTANT LECTURER IN PLANT DISEASES in the Department of Agricultural Botany—The Secretary and Registrar, University College of North Wales, Bangor (September 25).

ASSISTANT IN THE SCIENCE SERVICES DEPARTMENT, London Headquarters—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (September 25).

LECTURER (Grade II c or II b) IN PETROLEUM PRODUCTION ENGINEERING—The Secretary, The University, Edmund Street, Birmingham 3 (September 30).

BIOCHEMIST with experience of research in cellular metabolism or enzymology for a research post in the DEPARTMENT OF LACTATIONAL PHYSIOLOGY, to assist in the investigation of the intermediary metabolism of the mammary gland—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks (September 30).

I.C.I. RESEARCH FELLOWSHIP IN PHARMACOLOGY—The Secretary of University Court, The University, Glasgow (September 30).

READER or SENIOR LECTURER IN APPLIED MATHEMATICS in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (September 30).

LECTURER IN PSYCHOLOGY in the United College, St. Andrews—The Secretary, The University, St. Andrews (September 30).

ASSISTANT LECTURER IN BIOCHEMISTRY—The Registrar, King's College, Strand, London, W.C.2 (September 30).

SENIOR ASSISTANT IN THE PATHOLOGICAL DEPARTMENT—The Director, West Midlands Forensic Science Laboratory, Newton Street, Birmingham 4 (October 1).

LECTURER (Grade II c or II b) in MINING (Coal)—The Secretary, The University, Edmund Street, Birmingham 3 (October 1).

RESEARCH ASSISTANTSHIPS (2) for work on (*a*) Physical and Chemical Aspects of Selective Flotation, and (*b*) Mining Research Problems—The Registrar, The University, Leeds 2 (October 4).

SENIOR SCIENTIFIC OFFICERS, and SENIOR EXPERIMENTAL OFFICERS, for analytical work involving modern physico-chemical methods, in the Chemical Inspectorate (Atomic Energy), Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2281 (October 7).

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree in metallurgy, and experience in the metallography of light alloys) in the Ministry of Supply Headquarters in London—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2279 (October 8).

LECTURER IN MEDICAL ENTOMOLOGY—The Secretary, Department of Entomology and Parasitology, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool 3 (October 30).

BOTANISTS (2) to assist in the preparation of a Flora of East (Tropical) Africa, which is being undertaken by the Royal Botanic Gardens, Kew—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1 (October 31).

LECTURER IN MATHEMATICS AND PHYSICS in New England University College (University of Sydney), Armidale, N.S.W.—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (October 31).

SENIOR LECTURER (Grade I) IN THE DEPARTMENT OF GEOPHYSICS—The Secretary, The University, Edmund Street, Birmingham 3 (November 13).

PRODUCTION PILE MANAGER, and an INSTRUMENT MANAGER, IN THE DEPARTMENT OF ATOMIC ENERGY, Windscale Works, Sellafield, Cumberland—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

CIVILIAN LECTURER IN THE DEPARTMENT OF APPLIED MECHANICS of the Royal Naval College, Greenwich—The Secretary, The Admiralty (C.E. Branch I), London, S.W.1.

DEMONSTRATOR IN PHYSIOLOGY—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

LABORATORY TECHNICIAN (experience in electronics essential)—The Director, Neurological Research Unit, National Hospital, Queen Square, London, W.C.1.

TECHNICIAN (Grade B)—The Area Pathologist, Musgrove Park Hospital, Taunton.

ENTOMOLOGISTS and PLANT PATHOLOGISTS in the Scientific Department of the East African Groundnut Scheme—The Personnel Manager (Scientific), Overseas Food Corporation, Unilever House, London, E.C.4.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Quarterly Journal of Mechanics and Applied Mathematics. Vol. 1, Part I, March 1948. Pp. iv + 124. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 12*s.* 6*d.* net; annual subscription, 40*s.* [156

British Electrical and Allied Industries Research Association. Technical Report W/T 15: Electrical Pre-Warming of Tomato House Soil. By C. A. Cameron Brown and E. W. Golding. Pp. 26. (London: British Electrical and Allied Industries Research Association, 1948.) 18*s.* [166

British Agricultural Bulletin. (Published quarterly for Overseas circulation only.) Vol. 1, No. 1, Spring 1948. Pp. 40. (London: British Council, 1948.) 5*s.*; 15*s.* for 4 Nos. [216

Interdepartmental Committee on Social and Economic Research. Guides to Official Sources, No. 1: Labour Statistics. Material collected by the Ministry of Labour and National Service. Pp. iv + 22. (London: H.M. Stationery Office, 1948.) 9*d.* net. [216

Air Ministry. Pilot Error: some Laboratory Experiments. By Dr. D. Russell Davis. (A.P. 3139.A.) Pp. iv + 39. (London: H.M. Stationery Office, 1948.) 9*d.* net. [216

Department of Scientific and Industrial Research. Report of the Chemistry Research Board for the Period 1938–1946, with Report of the Director of the Chemical Research Laboratory for the Year 1946. Pp. iv + 68. (London: H.M. Stationery Office, 1948.) 1*s.* 3*d.* net. [226

Modern Influences on the University Aspect of Professional Training in Surveying. By Prof. C. A. Hart. Pp. ii + 24. (London: H. K. Lewis and Co., Ltd., 1948.) 2*s.* 6*d.* net. [236

Symposium on Searchlights. Containing a Series of Five Papers presented at a meeting of the Illuminating Engineering Society held in London on April 15, 1947, the Discussion on those Papers and a further Written Contribution. Pp. 164. (London: Illuminating Engineering Society, 1948.) 17*s.* 6*d.* [246

Where to Buy Everything Chemical. Pp. 220. (London: Where to Buy, Ltd., 1948.) [286

Birds Month by Month and Country Magazine. Vol. 1, No. 1, June–July. Pp. 40. (London: Allman and Son (Publishers), Ltd., 1948.) 2*s.* 6*d.*; annual subscription, 16*s.* [286

Other Countries

Flora of South Australia. (Handbook of the Flora and Fauna of South Australia, issued by the South Australian Branch of the British Science Guild, now incorporated with the British Association for the Advancement of Science.) Part 2: Casuarinaceae—Euphorbiaceae. By J. M. Black. Second edition. Pp. 253–521. (Adelaide: Government Printer, 1948.) 8*s.* 6*d.* [225

German Hydrographic Journal. (Issued with the authority of the Allied Control Council of Germany.) Vol. 1, No. 1, January 1948. Pp. 44. (Hamburg: German Hydrographic Institute, 1948.) 3.50 R. marks. [226

American Mosquito Control Association. Bulletin No. 1: The Use of Aircraft in the Control of Mosquitoes. Pp. 74. (New Brunswick, N.J.: American Mosquito Control Association, 1948.) 1.25 dollars; to non-Members, 1.50 dollars. [236

Carnegie Institution of Washington. Publication 175: Magnetic Results from Huancayo Observatory, Peru, 1922–1935. Pp. vi + 609. 3.25 dollars. Magnetic Results from Huancayo Observatory, Peru, 1936–1944. Pp. v + 385. 2 dollars. (Researches of the Department of Terrestrial Magnetism, Vols. 10A and 10B.) (Washington, D.C.: Carnegie Institution, 1948.) [286

South African Journal of Science. Vol. 44: Being the Report of the Forty-fifth Annual Meeting of the South African Association for the Advancement of Science, Oudtshoorn, 30th June to 4th July 1947. Pp. v + 157. (Johannesburg: South African Association for the Advancement of Science, 1948.) 30*s.* net. [286

Papers of the Michigan Academy of Science, Arts and Letters. Vol. 31 (1945). Pp. x + 325. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1947.) 21*s.* net. [286

Patents and Designs: Questions and Answers of Interest to Inventors and Industrialists. Pp. vii + 46. (Calcutta: Patent Office Society, 1948.) 2.8 rupees. [286

Atvinnudeild Háskólans (University Institute of Applied Sciences): Department of Agriculture. Reports, Series B, No. 2: Studies on the Origin of the Icelandic Flora, 1, Cyto-Ecoiogical Investigations on Cakile. By Askell Löve and Doris Löve. Pp. 29. Reports, Series B, No. 3: Chromosome Numbers of Northern Plant Species. By Askell Löve and Doris Löve. Pp. 131. (Reykjavik: University Institute of Applied Sciences, 1947–1948.) [286

United States Department of Commerce: National Bureau of Standards. Atomic Energy Levels as derived from the Analyses of Optical Spectra. Vol. 1, Section 1: The Spectra of Hydrogen, Deuterium, Helium, Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen and Fluorine. By Charlotte E. Moore. (Circular of the National Bureau of Standards, 467.) Pp. iii + 75. (Washington, D.C.: Government Printing Office, 1948.) 50 cents. [286